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Neogene Paleontology in the northern Dominican Republic

2. The Genus *Strombina* (Gastropoda: Columbellidae)

by

Peter Jung

Paleontological Research Institution
1259 Trumansburg Road
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NEOGENE PALEONTOLOGY IN THE NORTHERN DOMINICAN REPUBLIC

2. The Genus *Strombina* (Gastropoda: Columbellidae)

By

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ABSTRACT

Ten species of *Strombina* are discussed and their type specimens refigured. *S. cyphonotus* and *S. prisma,* two species belonging to the subgenus *Strombina,* although always listed in Dominican faunas, in all probability do not occur in the Dominican Republic at all. The stratigraphic range and the mode of occurrence of the remaining eight species is indicated. One subgenus (*Spiralta*) and one species (*S. canae*) are described as new. The subgenus *Sincola* dominates the fauna both in number of species and in numbers of individuals. The subgenus *Bifurcium* is represented by two species, the subgenus *Spiralta* by one.

RESUMEN

Diez especies de *Strombina* son discutidas y sus ejemplares tipos refigurados. *S. cyphonotus* y *S. prisma,* dos especies pertenecientes al subgénero *Strombina,* aunque siempre han sido listadas en la fauna dominicana, mucho más probablemente no aparecen en la República Dominicana. La distribución estratigráfica y el modo de aparición de las restantes ocho especies son indicados. Un subgénero (*Spiralta*) y una especie (*S. canae*) son descritos como nuevos. El subgénero *Sincola* predomina en la fauna tanto en número de especies como en número de individuos. El subgénero *Bifurcium* está representado por dos especies y el subgénero *Spiralta* por una.

INTRODUCTION

This is one of a series of taxonomic papers dealing with Neogene fossils from sections situated in the Cibao Valley, northern Dominican Republic (Text-fig. 1; Saunders, Jung, and Biju-Duval, 1986). The well-preserved faunas from that area have been famous for a long time. The earliest collections of molluscs have been described by G. B. Sowerby II* (1850), and Pflug (1961) revised some of Sowerby's species. The species described (but not figured) by Gabb (1873) have been redescribed and figured by Pilsbry (1922). However, all these papers are characterized by the lack of information on geographic locations and stratigraphic position. In this respect we find an improvement in Maury's papers (1917a, 1917b) with more, although not necessarily detailed information.

The material studied in this paper has been collected from measured sections. The geographic location of the investigated areas is shown in Text-figure 1. For detailed information as to geographic location and stratigraphic position of all the collecting stations, as well as to the general biostratigraphic framework and the ages, see the paper by Saunders, Jung, and Biju-Duval (1986). Formational names have been used with care, because correlations from section to section are not certain.

ACKNOWLEDGMENTS

The material on which this paper is based was collected during field work carried out in the years 1978, 1979, and 1980. The field work was made possible by a grant from the Swiss National Science Foundation (Grant 2.646–0.76). The financial help and the assistance in the field provided by Institut Français du Pétrole are gratefully acknowledged.

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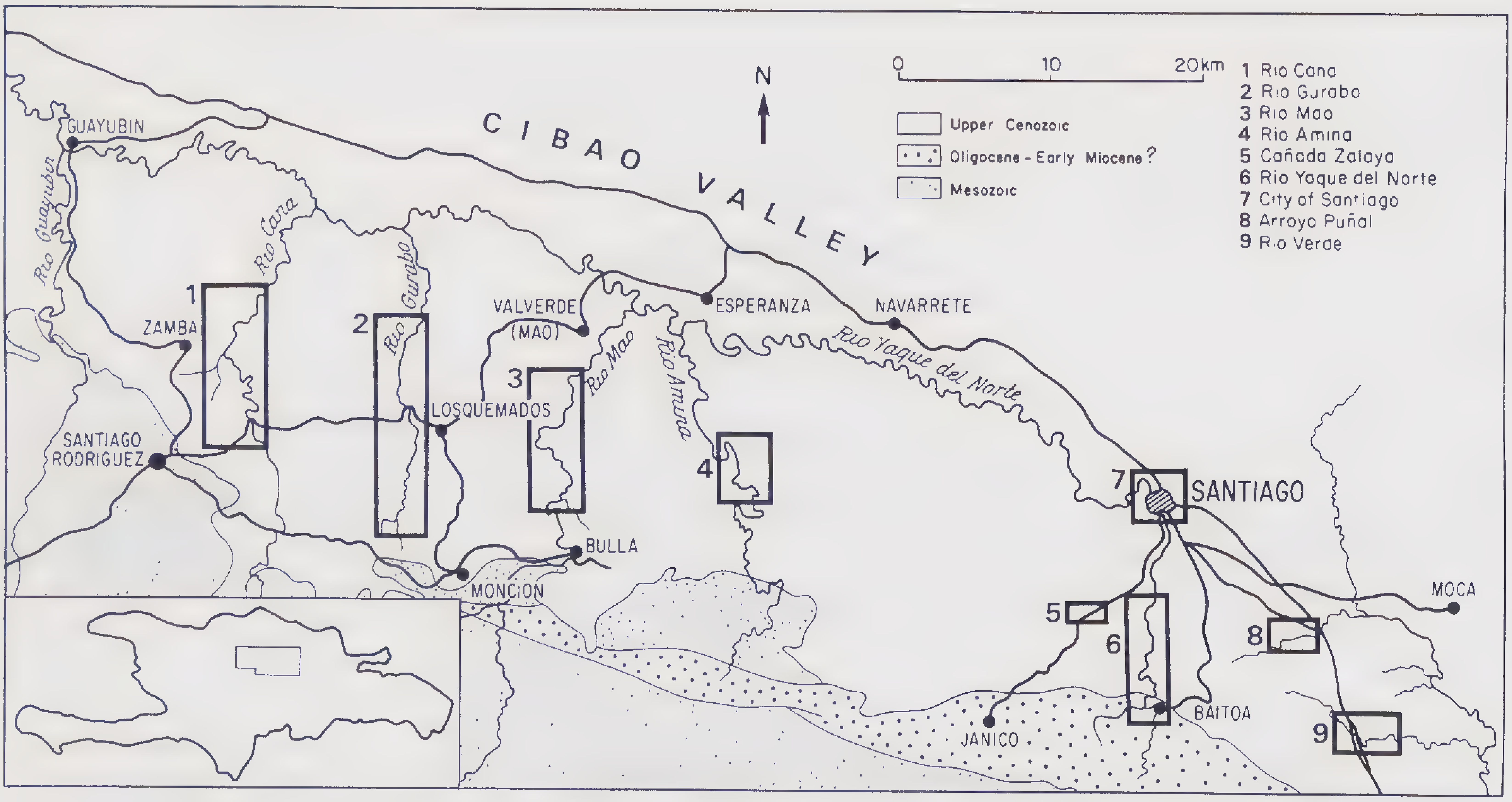
* There were three persons by the name of G. B. Sowerby (father, son, and grandson). They all published in the field of malacology, and it is therefore necessary to distinguish them. This has been done by Roman numbers. For additional information see Palmer (1966).



Text-figure 1.—Index map showing location of investigated areas in Cibao Valley, Dominican Republic.

In addition I am grateful to Mr. Wolfgang Suter, photographer at the Naturhistorisches Museum Basel as well as Dr. Richard Guggenheim and Mr. Marcel Düggelin, both of the Scanning Electron Microscope Laboratory, University of Basel, Switzerland. Dr. Fred Rögl, Naturhistorisches Museum Vienna, Austria, has dated a sample from the type section of the Río Banano Formation in Costa Rica.

BIOSTRATIGRAPHY

Out of the eight species of *Strombina* occurring in the Neogene of the Cibao Valley five are restricted to single sections. The other three species occur in more than one section.

S. guppyi is represented by a single specimen which was found at the stratigraphically highest locality of the Río Gurabo section, *i.e.*, in the middle to late Pliocene Mao Formation.

S. pseudohaitensis is known from the Río Mao section only and has been found over a horizontal distance of only about one kilometer, *i.e.*, between Maury's Bluffs 2 and 3. The dip of the beds in which it occurs is less than 5°, and its vertical range does not exceed 15 m. These beds are part of the Cercado Formation.

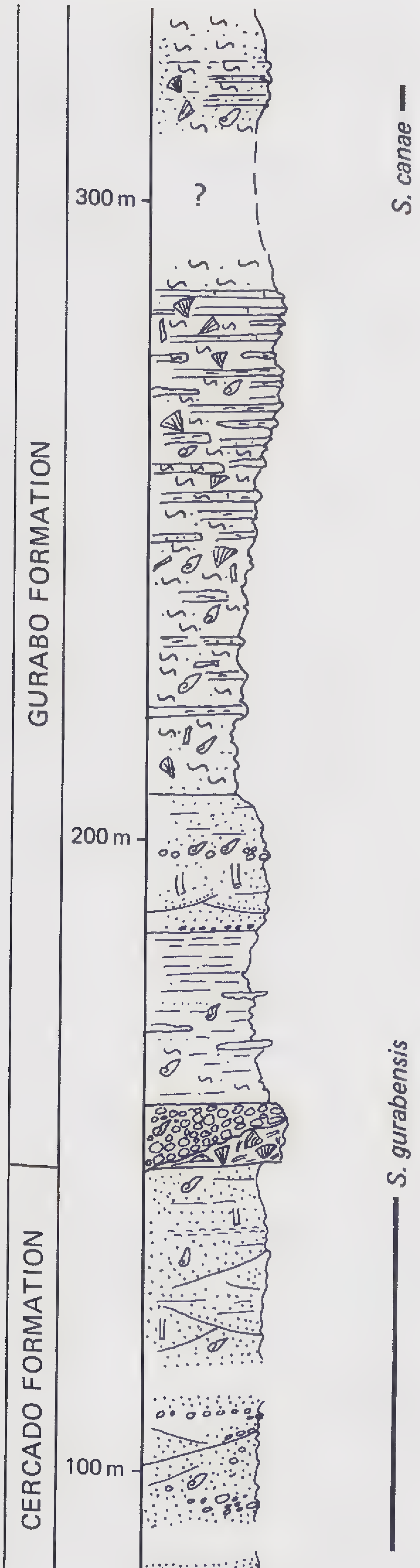
S. caribaea is restricted to the López section along Río Yaque del Norte north of the Village of Baitoa. This section exposes part of the Baitoa Formation (see Saunders, Jung, and Biju-Duval, 1986, text-fig. 25). The thickness of the sediments with *S. caribaea* is a little more than 40 m.

The remaining five species occur in the sections of Río Gurabo and Río Cana. Their stratigraphic ranges are shown in Text-figures 2 and 3. *S. gurabensis* is restricted to the top part of the Cercado Formation of the Río Gurabo section (thickness of sediments about 50 m), whereas *S. nanniebellae* only occurs in the upper part of the Cercado Formation of the Río Cana section (thickness of sediments about 130 m).

S. bassi, S. canae, and *S. nuestrasenorae* occur in both the Río Gurabo and Río Cana sections. *S. bassi* occurs in the Cercado Formation of the Río Cana section and in the top part of the Cercado Formation and the lowest part of the Gurabo Formation of the Río Gurabo section. *S. canae* has mainly been found in the Cercado Formation of the Río Cana section, but there is a single specimen from the Gurabo Formation of Río Gurabo. *S. nuestrasenorae* mainly occurs in the Gurabo Formation of the Río Gurabo section; a few specimens are known from beds in Arroyo Zalaya (Saunders, Jung, and Biju-Duval, 1986, text-fig. 36), which are tentatively assigned to the Gurabo Formation, and there is a single specimen from the Cercado Formation of the Río Cana section.

With the exception of *S. guppyi* which also occurs in sediments of Pliocene age of Jamaica and Costa Rica, all the species of *Strombina* here described are so far known only from the Neogene of the Dominican

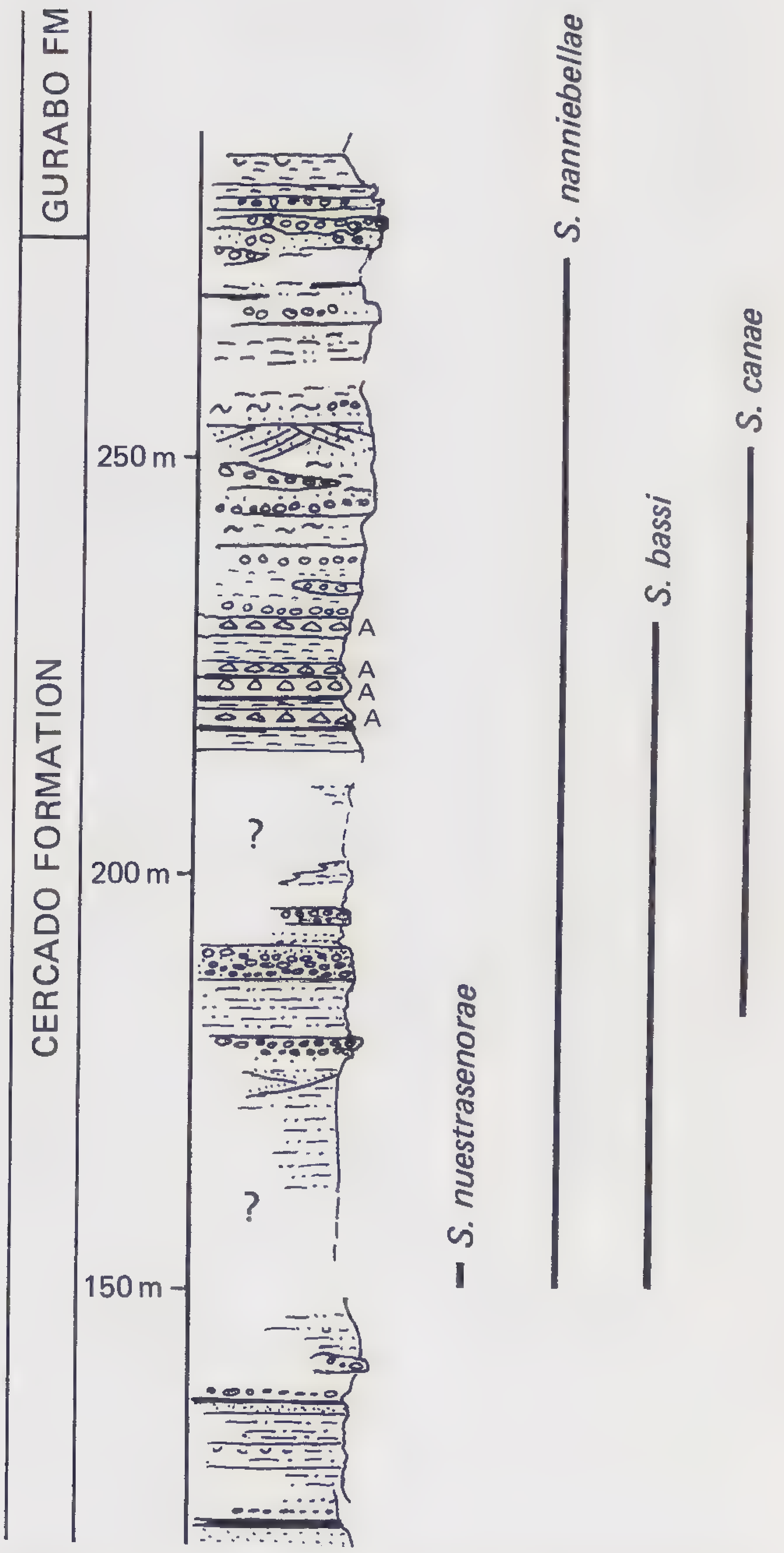
Text-figure 2.—Part of Río Gurabo section showing ranges of species of *Strombina*. Note the short range of *S. canae* at the top of this section. The range of *S. bassi* is discontinuous. →



Republic and hence are of only local biostratigraphic importance.

PALEOECOLOGY

The eight species of *Strombina* occurring in the areas studied are grouped in three subgenera: *Spiralta* (one species), *Sincola* (five species), and *Bifurcium* (two species). Each of these subgenera has at least one living representative neither of which is found in today's Caribbean faunal province, but only in Eastern Pacific waters.



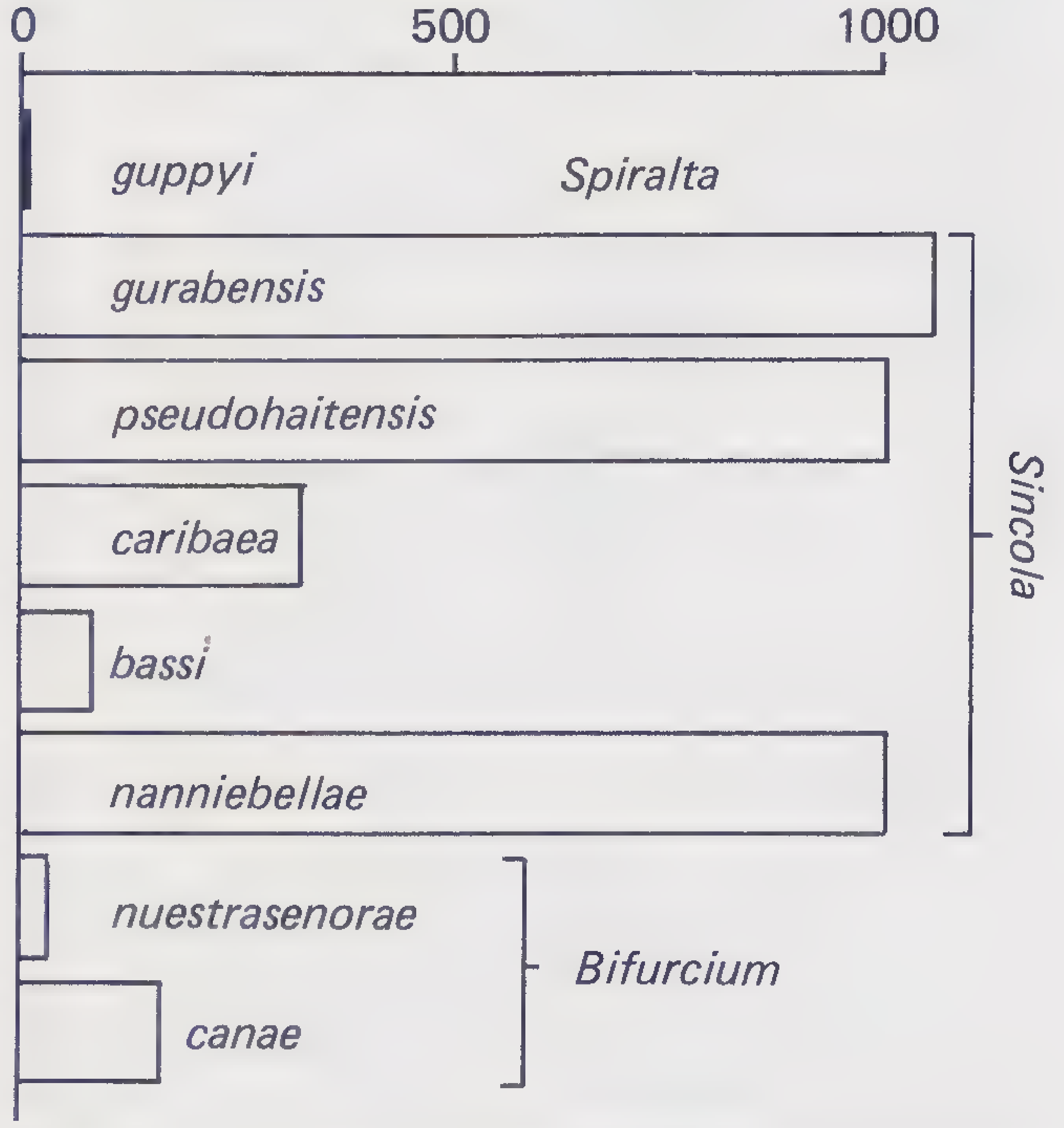
Text-figure 3.—Part of Río Cana section showing ranges of species of *Strombina*. Note the short range of *S. nuestrasenorae* in the lower part of the Cercado Formation.

The following all live in relatively shallow water: *S.* (*Spiralta*) *maculosa* (G. B. Sowerby I, 1832) lives "on mud flats and offshore to depths of 37 m" (Keen, 1971, p. 601); *S.* (*Sincola*) *gibberula* (G. B. Sowerby I, 1832) lives "intertidally and in depths to 100 m" (Keen, 1971, p. 600); and *S.* (*Bifurcium*) *bicanalifera* (G. B. Sowerby I, 1832) has been "dredged in sandy mud at a depth of ten fathoms" [= 18 m] (original description, p. 113). The bathymetric range of these species is therefore from 0 to 100 m.

The representation of the three subgenera among the fossils from the northern Dominican Republic is very unequal. Text-figure 4 shows that the majority of the species are assigned to *Sincola,* and that in terms of numbers of specimens they represent the bulk of the available material.

The mode of occurrence of each species (scattered in the sediment, in lenses, etc.) is mentioned in the taxonomic part of this paper. With the exception of the single specimen of *S. guppyi,* found in sands with pebbles, all the other species were associated with silty sediments. The majority of the specimens, however, has been found concentrated in shelly lenses, thin shell beds, or in conglomeratic layers. Thus there is little doubt that most of the *Strombina* material has been transported over some distance before final deposition.

The species here described seem to have lived in shallow water of normal salinity. As mentioned under *S. bassi,* some specimens of that species from Río Cana have been found associated with large numbers of *Arca*



Text-figure 4.—Diagram showing relative frequency of subgenera and species of *Strombina.*

patricia G. B. Sowerby II, 1850, and many, but not all of the shells from Río Cana are smaller than those from Río Gurabo. It is possible that the smaller size of these specimens is due to the influence of brackish water.

Considering the fact that practically nothing is known about the ontogeny and the life habits of living species of *Strombina,* it is difficult to make paleoecological statements of any precision. In addition it seems wiser to wait with paleoecological conclusions until the majority of the groups of fossils distributed to specialists for study is reassembled again, and the respective publications available.

One conclusion concerning the early ontogenetic development of the species considered herein can, however, be drawn with some confidence. A number of protoconchs have been studied with the aid of scanning electron microscope photography, and some of the photographs are reproduced on the accompanying plates. Two types of protoconchs can be observed: the first type shows a sinusigerous outer lip and is found in all the species of the subgenus *Sincola*; the second type has an opisthocyrt outer lip and has been observed in the two species assigned to the subgenus *Bifurcium.* According to Lebour (1945), Thorson (1950), and Shuto (1974), both types of protoconchs would point to pelagic larvae, or—more precisely—to planktotrophic larvae, *i.e.,* larvae that feed on phytoplankton (Thorson, 1950, p. 10). The protoconchs with a sinusigerous outer lip are "considered to be limited to the planktotrophic larval type of long pelagic period" (Shuto, 1974, p. 246).

ABBREVIATIONS OF REPOSITORY INSTITUTIONS

The following abbreviations for repository institutions are used in this paper:

ANSP: Academy of Natural Sciences, Philadelphia, PA, U.S.A.
BMNH: British Museum (Natural History), London, England, U.K.
NMB: Naturhistorisches Museum Basel, Switzerland (the letter H after NMB stands for gastropods)
PRI: Paleontological Research Institution, Ithaca, NY, U.S.A.
TU: Tulane University, New Orleans, LA, U.S.A.
USNM: United States National Museum of Natural History, Washington, DC, U.S.A.

SYSTEMATIC PALEONTOLOGY

INTRODUCTION

In this paper a total of 10 species of the genus *Strombina* is described. Two species of the subgenus *Strom-*

bina are discussed, and it is shown that in all probability these do not occur in the Dominican Republic. The remaining eight species belong to three subgenera: *Spiralta* (one species), *Sincola* (five species), and *Bifurcium* (two species). The field work on which this paper is based has provided ample opportunity for extensive collecting with the result that many of the species found are represented by large "populations". An attempt has been made to consult and refigure type specimens of all the taxa involved and to compare them with the "populations" of the new collections.

Being aware of the problems of biological species, the concept of population, when used in connection with fossils, has always been put in quotation marks and the approach in the following systematic part is largely morphological. This is obviously unsatisfactory to the neontologist, who would like to assess the amount of ecophenotypic variation within a given species. Similarly the application of "biological species" in paleontology meets with great difficulties. In the framework of the project on Neogene paleontology of the northern Dominican Republic it is certainly premature at this moment to interpret faunas in detail. Certain groups of fossils have been sent to various specialists for study. Once a good proportion of the taxonomic work has been published it may become possible to interpret more reliably the reassembled assemblages as to species concept, paleoenvironment, and biostratigraphic usefulness of individual species.

A good example illustrating the difficulty of applying a clear species concept is provided by two species of *Strombina*: *S. gurabensis* and *S. pseudohaitensis*. Both species are represented by more than 1000 specimens. Both lived during the deposition of part of the Cercado Formation, *i.e.*, penecontemporaneously, but not in the same area. *S. gurabensis* occurs in the Río Gurabo section and *S. pseudohaitensis* in the Río Mao section, *i.e.*, only about 10 km from each other. In addition their mode of occurrence in the silty sediments is similar. On the other hand there are consistent morphological differences described in the systematic part of this paper which persuaded me to keep the two species separate despite the initial temptation to place them in synonymy. Similar circumstances could be listed for *S. nuestrasenorae* and *S. canae*. I am waiting for good arguments against this practice.

Wherever possible the protoconchs of the species described below have been studied. The number of volutions of protoconchs is an integral part of their description. In order to avoid misunderstandings the method of counting volutions is shown in Text-figure 5.

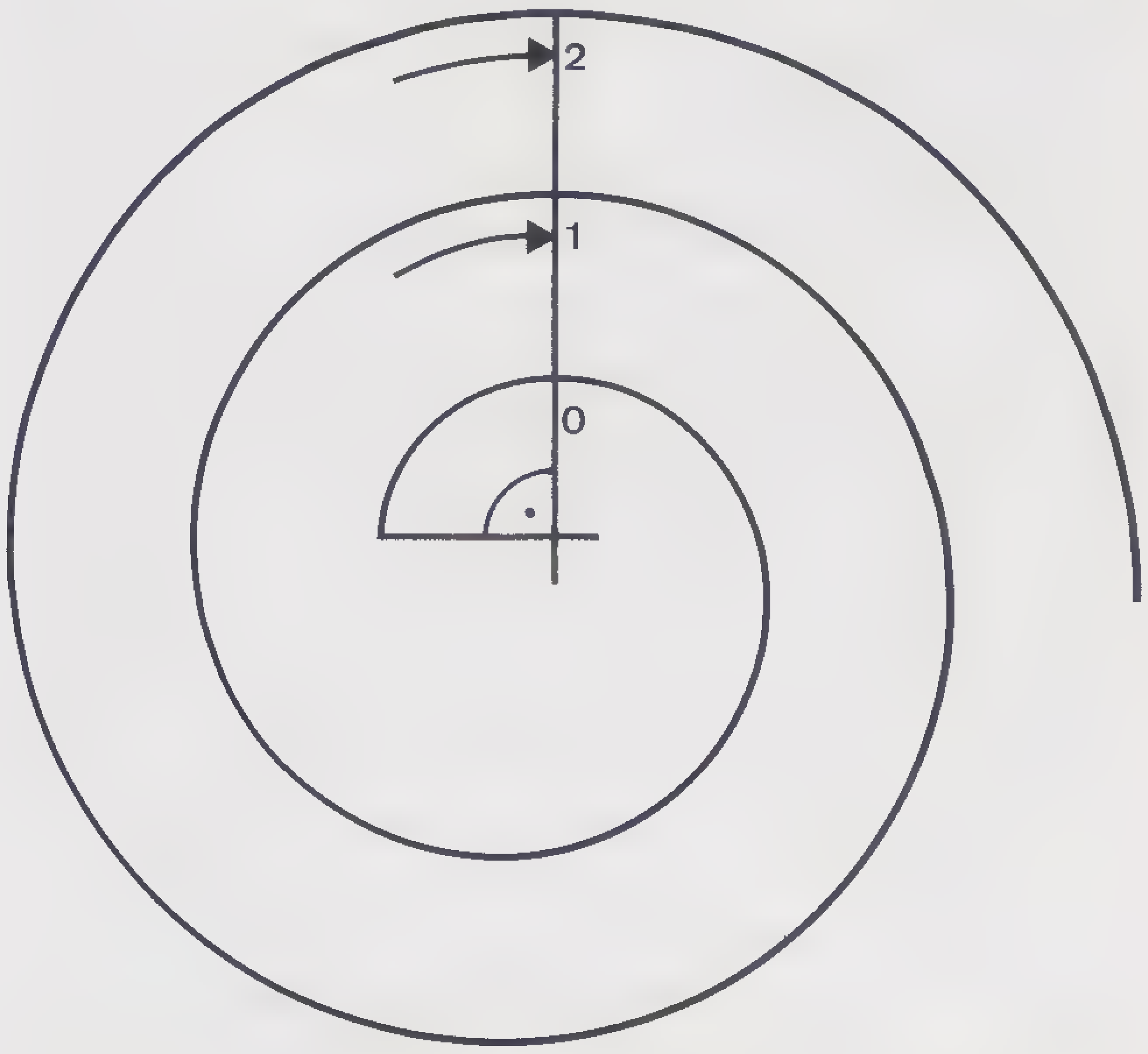
All the material from NMB localities is deposited at the NMB and only type, figured, or specially-mentioned specimens carry individual catalog numbers.

The heading "Diagnosis" is reserved for the description of supraspecific categories, whereas the heading "Description" is used only in species-level taxonomy. Under the heading "Description" follows a description of the species, not of specimens. If there is a (partial) description of a specimen, this is found under the headings "Remarks" or "Comparisons". The equivalent descriptive terms "volution" and "whorl" are both used, especially if they occur in the same sentence.

All generic, subgeneric, and species descriptions start with a general statement referring to size (*e.g.*, "of small size", "of medium to large size", etc.). In the case of generic and subgeneric descriptions these statements are not quantified, because only a few species of a given genus or subgenus are dealt with in this paper. A revision of the genus *Strombina* and related groups including both fossil and living species is now being prepared by the present writer. Although that study is still incomplete, the following preliminary figures for ranges of heights can be given: subgenus *Strombina*: 11–39 mm (small to large); subgenus *Spiralta*: 18–37 mm (medium to large); subgenus *Sincola*: 7–12 mm (small); subgenus *Bifurcium*: 7–15 mm (small).

The general statement referring to size in the descriptions of species is quantified under the heading "Measurements". The measurements of most species are plotted in a graph.

The term "restored height" occurs frequently in this paper. It refers to measured specimens, the tip of which is incomplete (part of the protoconch, the protoconch, or even early spire whorls missing). The total height has been measured by extrapolating with the naked



Text-figure 5.—Initial whorls of a gastropod showing mode of counting volutions. In this schematic drawing there are two-and-one-quarter whorls.

eye. The accuracy thus reached is sufficient for material of the size category reported on in this paper.

The heading "Occurrence" is followed by detailed geographic and stratigraphic information on a given species *within* the studied areas of the Dominican Republic. Under the heading "Distribution" there is general geographic and stratigraphic information on a given species within the Dominican Republic *plus* such information *outside* the Dominican Republic.

Genus STROMBINA Mörch, 1852

Strombina Mörch, 1852, p. 85.
Strombocolumbus Cossmann, 1901, p. 241.

Type species (by subsequent designation, Bucquoy, Dautzenberg, and Dollfus, 1882, p. 78).—*Columbella lanceolata* G. B. Sowerby I, 1832, p. 116. Recent, Ecuador and Galapagos Islands.

Diagnosis.—Shell of small to large size. General shape ranging from fairly stout to slender. Spire usually high. Sculpture may be lacking except for a varying number of spiral cords near the base, but axial ribs are the predominant sculptural elements. Outer lip generally thickened, with or without denticles on inner surface. Parietal callus present. Anterior canal more or less recurved.

Remarks.—The genus *Strombina* lives in tropical waters of the Western Hemisphere. Before 1950 the living representatives of the genus were thought to be restricted to the Eastern Pacific, an area from which more than 20 species have been described. For this reason Rutsch (1934, p. 68) considered the occurrence of *Strombina* in Pleistocene sediments of the Cabo Blanco area of Venezuela as remarkable. This Pleistocene species was later described as *S. caboblanquensis* Weisbord, 1962 (p. 323, pl. 28, figs. 25–30, pl. 29, figs. 1–4). Woodring (1964, p. 252) reported on the discovery of *S. pumilio* (Reeve, 1859): "In 1950 R. W. Foster . . . dredged specimens off Scarborough, Tobago, at a depth of 36 fathoms." Gibson-Smith and Gibson-Smith (1974, p. 52) listed additional localities on the mainland of Venezuela and the Island of Margarita, where Recent specimens of *S. pumilio* had been found. According to these authors *S. pumilio* also occurs in Holocene beach deposits of mainland Venezuela, in raised beaches of the Araya Peninsula and the Island of Margarita, and in Pleistocene beds of the Araya Peninsula. Vink (1979, p. 7) reported on live *S. pumilio* from Playa Santa Cruz near Cumaná, Venezuela, found at a depth of 3 m "where it crawled in a habitat of coarse sand and fine algae". A second Recent Caribbean species has been described from Cayo Francés, Islas Los Roques, Venezuela, under the name of *S. francesae* J. Gibson-Smith *in* Gibson-Smith and Gibson-Smith, 1974 (p. 54, pl. 2, figs. 1–4).

Petuch (1981, p. 323, figs. 35, 36) reported on the occurrence of living *S. caboblanquensis* Weisbord in depths of 15 to 40 m along the coast of Venezuela and on an unidentified species of *Strombina* (Petuch, 1981, p. 323, figs. 39, 40) from a depth of 35 m in the Golfo de Triste, Venezuela. These records increase the number of species of *Strombina* living in the Caribbean Sea to four. The geographic distribution of these four Recent species as now known is restricted to a relatively small area within the southeastern Caribbean Sea.

In contrast to the weak representation of the genus in the Recent Caribbean fauna, *Strombina* is widespread in Neogene sediments of the area, thus reflecting the closing of the isthmus between the two Americas during the Neogene. Almost 50 names of species of *Strombina* have been proposed for the eastern part of the Tertiary Caribbean faunal province alone, and the total age range of the genus is early Miocene to Recent.

Subgenus STROMBINA sensu stricto

Diagnosis.—Shell of small to large size, slender. Spire high. Sculpture on spire whorls predominantly axial, often becoming less conspicuous on late spire whorls. Aperture long and narrow. Parietal callus prominent. Outer lip thickened, with denticles on inner surface. Body whorl higher than half the height of the complete shell. The thickening of the outer lip and two additional thickenings at intervals of 120° in most species result in triangular cross-sections of the body whorl. Anterior canal recurved. Suture of body whorl somewhat ascending.

Remarks.—*S. pumilio, S. francesae, S. caboblanquensis,* and *Strombina* sp. of Petuch (1981, p. 323), the four living Caribbean species, all belong to the subgenus *Strombina* s. s. According to Radwin (1977, p. 407) *S. pumilio* prefers a sandy substrate and preferably lives on the middle shelf, *i.e.,* in depths of 22 to 80 m. The following ecologic information on *S. francesae* is based on notes by Willard Brownell dated February 25, 1976. These notes were kindly sent to me by J. Gibson-Smith. Brownell states that *S. francesae* is relatively common in the western part of the Los Roques Archipelago. He had found about 20 live specimens buried in loose sand 1 to 4 cm below the surface at water depths ranging from 1 to 18 m. In addition he found numerous shells of *S. francesae* inhabited by hermit crabs.

The fossil record of the Tertiary Caribbean faunal province contains about 20 species of this subgenus. According to the literature two species of the subgenus *Strombina* are said to occur in the Neogene of the Dominican Republic: *S. cyphonotus* and *S. prisma.* As discussed below there is a high probability that neither of these species occurs in the Dominican Republic.

Strombina (Strombina) cyphonotus
Pilsbry and Johnson
Plate 1, figures 1–9; Text-figure 6

Strombina gradate [*sic*] Gabb, 1873, p. 221 (in part). Not *Columbella gradata* Guppy, 1866, p. 288, pl. 16, fig. 10.
Strombina cyphonotus Pilsbry and Johnson *in* Brown and Pilsbry, 1911, p. 353 (footnote), pl. 25, figs. 6, 7; Maury, 1917a, p. 97, pl. 15, figs. 7, 8; Pilsbry, 1922, p. 351; Weisbord, 1929, p. 42, pl. 7, figs. 9, 10.

Description.—Shell of medium size. Spire moderately high. Protoconch not known. Up to eight postnuclear whorls. Early whorls almost flat in profile, later ones slightly convex. Spire whorls smooth except for faint, somewhat prosocline growth lines. On later spire whorls there may be a rudimentary, inconspicuous axial sculpture consisting of narrow, distant axial ribs on the upper half of the whorl. Dorsal hump with a few narrow axial ribs. Base of body whorl sculptured by spiral cords. Anterior canal moderately long, slightly recurved. Outer lip thickened, with five to nine denticles on inner surface. Callus on inner lip prominent, lacking denticles.

Lectotype (herein selected).—ANSP 3293 (Pl. 1, figs. 1–3). This is the specimen illustrated by Brown and Pilsbry (1911, pl. 25, fig. 6). Pilsbry (1922, p. 351) mentioned "the type and eight other specimens are no. 3893 A.N.S.P." [instead of 3293], but did not designate a particular specimen as the "type" and therefore did not select a lectotype. Pilsbry and Johnson *in* Brown and Pilsbry (1911, p. 353) gave the measurements of the specimen figured by Brown and Pilsbry (1911, pl. 25, fig. 6) and probably considered this as the "type" without explicitly stating it. After these measurements (which are not quite correct) they continue: "Other specimens of the type lot measure: . . .". For this reason the specimen mentioned above is selected as the lectotype.

Dimensions of lectotype.—Height (incomplete): 23.5 mm; width: 11.2 mm.

Type locality.—Not known. Maury (1917a, p. 97, pl. 15, figs. 7, 8) mentioned and figured *S. cyphonotus,* but said little about the species and gave no locality information as she usually did for other species. In 1974 I received three specimens of *S. cyphonotus* from J. W. Wells, which are said to come from C. J. Maury's collection, but were actually part of Gabb's collection as stated on an old label accompanying the specimens. This seems to be proof that Maury never found *S. cyphonotus* in the Dominican Republic, but received some specimens from Philadelphia labeled as coming from "Santo Domingo" (without any further locality information). State of preservation and coloration of these three specimens are exactly the same as those of the specimens of the type lot.

S. cyphonotus is thus not represented in the material Maury collected in the Dominican Republic; nor has it been found by E. H. and H. E. Vokes, nor by our own field party. It is therefore highly probable that *S. cyphonotus* (as well as *S. prisma*: see below) does not occur in the Dominican Neogene. The specimens must have been mislabeled at an early stage: at least this seems to be the most probable source of confusion.

Material.—A total of 13 specimens have been studied: the lectotype, eight paralectotypes, the specimen figured by Weisbord (1929, pl. 7, figs. 9, 10), and the three specimens from Gabb's collection mentioned above.

Measurements (in mm).—

	height	*restored height*	*width*	*ratio of restored height to width*
ANSP 3293 (lectotype) [see Pl. 1, figs. 1–3]	23.5	24.5	11.2	2.2
ANSP 60173 (paralectotype)	19.8	21.5	10.2	2.1
ANSP 60173 (paralectotype)	21.7	23.4	11.2	2.1
ANSP 60173 (paralectotype)	21.8	23.4	10.1	2.3
ANSP 60173 (paralectotype)	22.2	22.6	10.3	2.2
ANSP 60173 (paralectotype)	22.4	23.8	10.6	2.2
ANSP 60173 (paralectotype) [see Pl. 1, figs. 4–6]	22.7	23.7	11.1	2.1
ANSP 60173 (paralectotype)	23.3	24.7	11.2	2.2
ANSP 60173 (paralectotype)	23.4	24.6	10.4	2.4
PRI 22962 (figured by Weisbord, 1929) [see Pl. 1, figs. 7–9]	20.5	22.7	10.4	2.2
NMB H 17147 (from Gabb collection)	18.0	19.5	8.6	2.3
NMB H 17148 (from Gabb collection)	21.6	23.0	10.0	2.3
NMB H 17149 (from Gabb collection)	22.2	23.2	10.6	2.2

Remarks.—The axial sculpture on the late spire whorls is variable. When present it is weak, but on some specimens it is absent altogether. Although the cross-section of the body whorl is basically triangular, the thickening to the left of the aperture is more or less well developed.

Comparisons.—*S. cyphonotus* has a stouter appearance than *S. prisma.* Its apical angle is larger than that of *S. prisma,* and its anterior canal is shorter. On an average *S. cyphonotus* is smaller than *S. prisma* (see Text-fig. 5).

Occurrence.—As stated above it is most likely that *S. cyphonotus* does not occur in the Neogene of the Dominican Republic.

Distribution.—The only more or less reliable record of this species is the single specimen described and figured by Weisbord (1929, p. 42, pl. 7, figs. 9, 10, refigured here on Pl. 1, figs. 7–9). It was collected "between Las Perdices and Pto. Colombia, Dept. of Atlantico", Colombia, and the age is given as "Miocene".

Strombina (Strombina) prisma
Pilsbry and Johnson
Plate 2, figures 1–9; Text-figure 6

Strombina gradate [*sic*] Gabb, 1873, p. 221 (in part). Not *Columbella gradata* Guppy, 1866, p. 288, pl. 16, fig. 10.

Strombina prisma Pilsbry and Johnson *in* Brown and Pilsbry, 1911, p. 352 (footnote), pl. 25, figs. 9, 10; Maury, 1917a, p. 97, pl. 15, figs. 9, 10; Pilsbry, 1922, p. 351.

Description.—Shell of medium size. Spire high. Protoconch not known. Up to eight-and-one-half postnuclear whorls. Early spire whorls almost flat in profile, late spire whorls slightly convex. Postnuclear whorls practically smooth except for slightly prosocline growth lines; a faint spiral striation may be present. Dorsal hump with a few short and narrow axial ribs or accentuated growth lines. Suture between early spire whorls in some cases channeled. Base of body whorl with strong spiral cords. Anterior canal long. Outer lip with six to 10 denticles. Callus on inner lip strong, without denticles.

Lectotype (herein selected).—ANSP 3292 (Pl. 2, figs. 1–3). This is the specimen illustrated by Brown and Pilsbry (1911, pl. 25, fig. 10). Pilsbry (1922, p. 351) mentioned "the type and six other specimens are no. 3292 A.N.S.P.", but he did not designate a particular specimen as the "type" and therefore did not select a lectotype.

Dimensions of lectotype.—Height (incomplete): 26.0 mm; width: 10.6 mm.

Type locality.—Not known. Maury (1917a, p. 97, pl. 15, figs. 9, 10) mentioned and figured *S. prisma,* but said little about the species and gave no locality information as she usually did for other species. Although not absolutely certain, it is highly probable that Maury did not collect the species herself, but somehow had received specimens from the Gabb collection in Philadelphia. As no later collectors have ever found *S. prisma* again it is concluded that *S. prisma* most probably does not occur in the Neogene of the Dominican Republic at all (see also under *S. cyphonotus*).

Material.—Only the lectotype and six paralectotypes have been studied.

Measurements (in mm).—

	height	*restored height*	*width*	*ratio of restored height to width*
ANSP 3292 (lectotype) [see Pl. 2, figs. 1–3]	26.0	26.6	10.6	2.5
ANSP 60174 (paralectotype)	22.0	24.1	9.2	2.6
ANSP 60174 (paralectotype) [see Pl. 2, figs. 7–9]	22.8	24.1	10.5	2.3
ANSP 60174 (paralectotype)	24.0	25.6	10.8	2.4
ANSP 60174 (paralectotype)	25.5	27.0	9.8	2.8
ANSP 60174 (paralectotype) [see Pl. 2, figs. 4–6]	25.7	27.2	10.0	2.7
ANSP 60174 (paralectotype)	29.0	30.0	12.6	2.4

Remarks.—The seven specimens of the type lot show some variability. The prominence of the axial sculpture on the dorsal hump is variable, but it may be absent altogether. Furthermore the suture between early spire whorls is channeled in some cases. The lectotype does not have a channeled suture, but several of the paralectotypes do (see Pl. 2, figs. 4–6).

Comparisons.—*S. prisma* is most closely related to *S. lessepsiana* Brown and Pilsbry, 1911 (p. 352, pl. 25, figs. 11, 12) from the Gatun Formation of the Panama Canal Zone. According to Woodring (1964, p. 253, pl. 40, figs. 22, 23, 30, 31) *S. lessepsiana* is quite abundant in the Gatun Formation; specimens from the lower part of the formation are larger than those from the middle and upper parts. The axial sculpture is strongly variable: the whorls of specimens with axial ribs are somewhat shouldered, but if the axial sculpture is absent, the profile of the whorls is almost straight. None of the specimens of the type lot of *S. prisma* has axial sculpture. The type lot of *S. lessepsiana* (ANSP 1718) consists of seven specimens: four of them are fragmentary; the remaining three shells lack axial sculpture and are thus so similar to *S. prisma* that one is tempted to consider them as one species.

S. waltonia Gardner, 1947 (p. 513, pl. 52, figs. 26–28) from the middle Miocene Shoal River Formation of Florida essentially is a smaller species. Most of the many specimens of *S. waltonia* from the Shoal River Formation of Florida at hand, which were kindly sent for comparison by E. H. Vokes, have axial sculpture on later spire whorls and are shouldered to some degree. On some specimens the axial sculpture is absent.

S. striatocostata Marks, 1951 (p. 110, pl. 7, fig. 7) from the middle (?) Miocene Daule Formation of Ec-

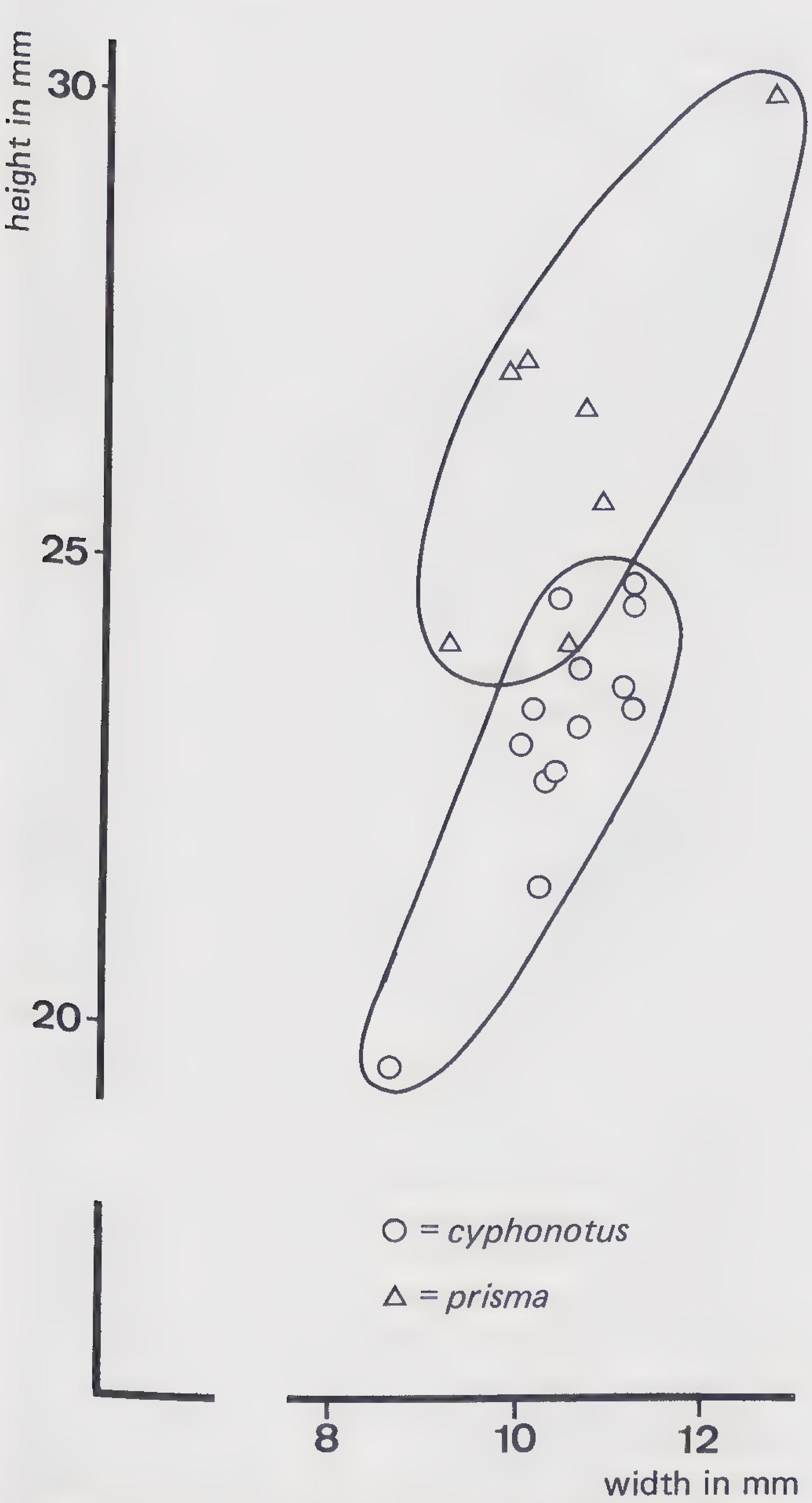
uador is another similar species. It is smaller than *S. prisma* and has a more pronounced axial sculpture.

Occurrence.—Not known (see above). There is a high probability that this species does not occur in the Neogene of the Dominican Republic.

Distribution.—As the seven specimens of the type lot of this species are the only specimens known, and as their type locality is not known, the distribution of the species is not known either.

Subgenus **SPIRALTA**, new subgenus

Etymology of name.—L. *spira* = spire; L. *altus* = high; gender feminine.



Text-figure 6.—Graph showing (restored) height/width relationship of *S. cyphonotus* and *S. prisma*.

Type species (herein designated).—*Strombina maculosa* (G. B. Sowerby I, 1832, p. 116). Living, Gulf of California to Ecuador. A syntype of *S. maculosa* is figured here (Pl. 3, figs. 1–3).

Diagnosis.—Shell of medium to large size, slender. Spire high, considerably higher than height of aperture. Sculpture predominantly axial, consisting of straight or somewhat sigmoid axial ribs or knobs just below the suture, which may be axially-elongated. Axial sculpture weak or absent on early spire whorls. Spiral sculpture restricted to base of body whorl. Outer lip somewhat thickened; denticulation on its inner surface varying from almost absent to moderately well developed. Parietal callus present but not prominent. Cross-section of body whorl circular except for the moderate thickening of the outer lip.

Remarks.—The subgenus *Spiralta* is easily distinguished from *Strombina* s. s. The proportion of the height of the aperture to the height of the spire is very different: in *Spiralta* the spire is much higher than in *Strombina* s. s. In addition *Spiralta* has a prominent axial sculpture on later spire whorls which is usually lacking in *Strombina* s. s. Furthermore *Strombina* s.s. has a dorsal hump on the body whorl resulting in a triangular cross-section of the body whorl, whereas the cross-section of the body whorl of species of *Spiralta* is circular due to the lack of a dorsal hump.

As now known the subgenus *Spiralta* comprises two fossil species: *S. falconensis* H. K. Hodson *in* Hodson and Hodson, 1931, from the late Miocene Caujarao Formation of Falcón, Venezuela, and *S. guppyi* Woodring, 1928, from the early Pliocene Bowden Formation of Jamaica. In addition three Recent species from the Eastern Pacific are assigned to *Spiralta*: *S. elegans* (G. B. Sowerby I, 1832), the type species, *S. maculosa* (G. B. Sowerby I, 1832), and *S. paceana* Dall, 1916. According to Keen (1971, p. 601) *S. maculosa* lives on mud flats and to depths of 37 m. *S. maculosa* has also been cited from the Pliocene of Carmen Island, Gulf of California, Mexico, by Hanna and Hertlein (1927, p. 147), but not from Pleistocene deposits of that area (Grant and Gale, 1931, p. 699). The stratigraphic range of *Spiralta* is therefore late Miocene to Recent.

Strombina (Spiralta) guppyi Woodring
Plate 3, figures 4–6

Columbella ambigua Guppy, 1866, p. 288, pl. 16, fig. 8; Guppy, 1874, p. 439.
Columbella [*Strombina*] *ambigua* Guppy. Pace, 1902, p. 52.
Strombina ambigua Guppy. Gabb, 1873, p. 221; Olsson, 1922, p. 126, pl. 10, fig. 9.
Not *Columbella ambigua* Kiener, 1841, p. 11.
Strombina guppyi Woodring, 1928, p. 282, pl. 17, fig. 2.

Description.—Shell of medium size, slender. Spire high. Protoconch consisting of one-and-one-quarter whorls. About eight postnuclear whorls. Spire whorls straight to slightly convex in profile. Axial sculpture consisting of 20 to 23 straight to slightly sigmoid axial ribs per whorl extending from suture to suture. On the body whorl the axial ribs may be restricted to the upper part. On early spire whorls the axial sculpture may be absent. Base of body whorl with some spiral cords. Outer lip only slightly thickened, having a few elongate denticles on its inner surface. Parietal callus not prominent. Body whorl circular in cross-section.

Holotype.—USNM 115514.

Dimensions of holotype.—Height (incomplete): 27.8 mm; width: 10.2 mm.

Type locality.—Bowden, Jamaica. Bowden Formation, early Pliocene.

Material.—A single, incomplete specimen (NMB H 17059; see Pl. 3, figs. 4–6) from the Dominican Republic is available.

Measurements (of NMB H 17059).—Height: 22.6 mm; width: 8.6 mm.

Remarks.—The only available specimen consists of four whorls showing remnants of a reddish-brown coloration. It is somewhat more slender than the three topotypes at hand. The early spire whorls of one of the topotypes are smooth. Woodring (1928, p. 283) described the protoconch of *S. guppyi* as consisting of one-and-one-quarter whorls. This cannot be confirmed here as none of the specimens at hand have their protoconch preserved.

The specimen from the "Gatun Stage" of the "Banana River" section of Costa Rica described and figured by Olsson (1922, p. 126, pl. 10, fig. 9) is also incomplete. According to F. Rögl (written commun., 1973) at least part of the Banana River section falls within the *Globorotalia margaritae* Zone (early Pliocene). Gomez and Valerio (1971, p. 43) include this section in the Rio Banano Formation.

Comparisons.—The species most closely related to *S. guppyi* obviously is *S. falconensis* H. K. Hodson *in* Hodson and Hodson, 1931, from the late Miocene Caujarao Formation of Falcón, Venezuela. The late spire whorls of *S. guppyi* are slightly convex in profile, whereas those of *S. falconensis* are practically straight. The 15 topotypes of *S. falconensis* at hand as well as the topotype figured by Gibson-Smith and Gibson-Smith (1974, pl. 3, figs. 1, 2) show that the axial ribs do not extend from suture to suture as in *S. guppyi* but are restricted to the upper part of the spire whorls. The tendency towards slightly sigmoid axial ribs in *S. guppyi* is not seen in *S. falconensis.*

No specimens of the Recent Eastern Pacific species *S. elegans* (G. B. Sowerby I, 1832) are at hand for comparison. According to the figure given by Keen (1971, fig. 1271), *S. elegans* has the same type of axial sculpture as *S. guppyi* but is larger.

Occurrence.—Río Gurabo: NMB locality 15833 (see Saunders, Jung, and Biju-Duval, 1986, text-fig. 4). This locality is at the top of the measured section and falls within the Mao Formation (middle or late Pliocene).

Distribution.—Jamaica: Bowden Formation (early Pliocene). Costa Rica: Rio Banano Formation (early Pliocene?). Dominican Republic: Mao Formation (middle or late Pliocene).

Subgenus **SINCOLA** Olsson and Harbison

Sincola Olsson and Harbison, 1953, p. 230.

Type species (by original designation and tautonymy).—*Strombina sincola* Olsson, 1922. "Miocene" of Costa Rica.

Diagnosis.—Shell of small size. General shape ranging from moderately stout to slender. Height of aperture about half the total height of shell or somewhat more. Sculpture predominantly axial. Axial sculpture usually restricted to early spire whorls. Spiral sculpture usually restricted to base of body whorl. Outer lip thickened, mostly with prominent denticles on its inner surface. Anterior canal short and recurved.

Remarks.—Among the *Strombina* material from the northern Dominican Republic the subgenus *Sincola* is by far the most prominent group. There are five species represented by numerous specimens.

Sincola is widely distributed throughout the Neogene Caribbean faunal province. There are almost 20 species names available for this subgenus alone. A single species survives in eastern Pacific waters: *S. gibberula* (G. B. Sowerby I, 1832) which according to Keen (1971, p. 600, fig. 1273) ranges from Baja California to Peru and lives intertidally to depths of 100 m. *S. gibberula* is also recorded from Pleistocene beds of Lower California, Mexico, by Grant and Gale (1931, p. 699) and from the Pliocene of western Ecuador by Pilsbry and Olsson (1941, pp. 7, 35).

The protoconchs of the species of *Sincola* to be described all have a sinusigerous outer lip. They are assumed to be pelagic larvae (Thorson, 1950), and this particular type of protoconch is interpreted as a planktotrophic larva with a long pelagic life (Shuto, 1974, p. 246).

Before considering this type of protoconch as characteristic of the subgenus *Sincola,* additional species of *Sincola* and in particular the living *S. gibberula* would have to be studied.

Strombina (Sincola) gurabensis (Maury)
Plate 3, figures 7–9; Plate 4, figures 1–9;
Plate 6, figures 1–7; Text-figures 7, 9, 10, 11

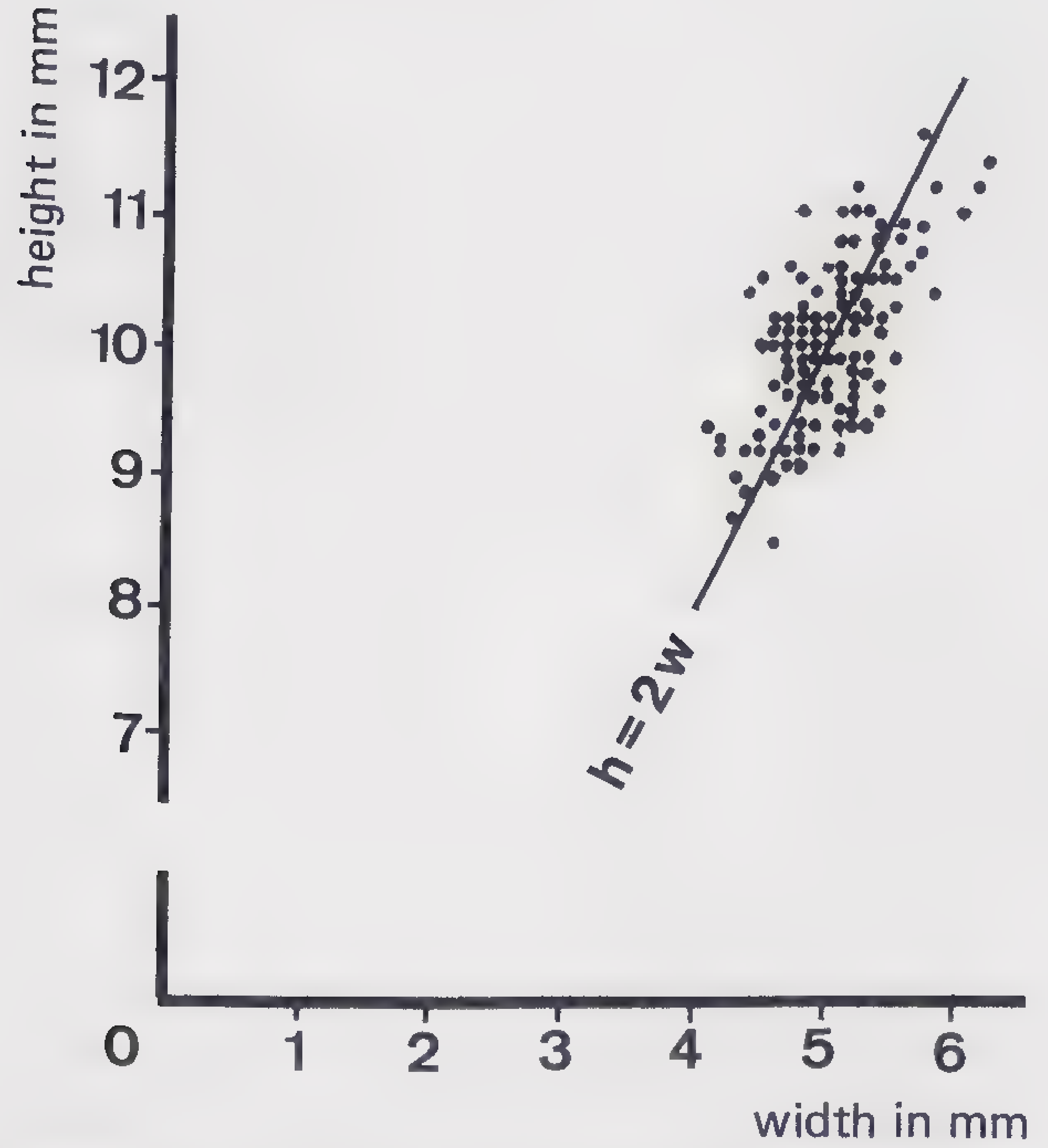
Columbella (*Strombina*) *pseudohaitensis gurabensis* Maury, 1917a, p. 95, pl. 15, fig. 14.

Description.—Shell of small size, moderately slender. Protoconch smooth, consisting of about three volutions not counting the sinusigerous outer lip. Postnuclear whorls five to six. The first one to three postnuclear whorls sculptured by axial riblets. There are 12 to 14 axial ribs per whorl. The earliest axial riblets may be slightly opisthocyrt, otherwise they are orthocline to somewhat prosocline. The whorls having axial ribs are shouldered, and the ribs themselves usually are more prominent toward the lower suture. Later spire whorls somewhat convex in profile, their surface smooth except for growth lines. Base of body whorl sculptured by a varying number of spiral cords. Outer lip thickened, with or without denticles on its inner surface.

Holotype.—PRI 28734 (see Pl. 4, figs. 1–3). The holotype is not quite an adult and its outer lip not yet thickened.

Dimensions of holotype.—Height (not quite complete): 7.3 mm; width: 3.4 mm.

Type locality.—Río Gurabo at Los Quemados, Dominican Republic. This is not precise. For this reason the type locality is here restricted to NMB locality 15903 (Saunders, Jung, and Biju-Duval, 1986, text-fig. 4).



Text-figure 7.—Height/width diagram of *S. gurabensis* with line indicating heights corresponding to two widths (h = 2w).

Material.—Maury (1917a, p. 96) stated that this species is rare. The present study of this species on the other hand is based on well over a thousand well-preserved specimens. At the type locality alone it is represented by at least 300 specimens. As shown by the scanning electron micrographs (Pl. 6, figs. 1–7) the protoconchs are somewhat corroded, and their surfaces are thus not very well preserved.

Measurements.—The large amount of material available makes it possible to draw meaningful height/width diagrams. In Text-figure 7 the measurements of "populations" of 50 adult individuals from NMB localities 15903, 15904, and 15907 (Saunders, Jung, and Biju-Duval, 1986, text-fig. 4) are plotted. The three "populations" have not been marked individually in Text-figure 7, because they do not show different patterns; on the contrary, quite a number of specimens have identical measurements. The line indicating heights corresponding to two widths (h = 2w) cuts almost across the middle of the field of size variability, which means that the shells are about twice as high as wide.

Remarks.—*S. gurabensis* is a fairly variable species. The denticles on the inner surface of the outer lip may be well developed, there may be only a few, or they may be absent altogether. Another variable feature is the axial sculpture on the early spire whorls. The development of the callus on the parietal wall is also variable. Figures 3 and 7 on Plate 6 suggest that the length of the sinusigerous outer lip of the protoconch is not constant.

S. gurabensis has only been found in shell beds interbedded with silts and in conglomeratic shell beds. Thus it seems that the shells have been transported over a short distance before final deposition.

Comparisons.—*S. gurabensis* is closely related to *S. pseudohaitensis.* The relationship of the two species will be discussed under the latter. *S. lampra* Gardner, 1947, from the middle Miocene Shoal River Formation of Florida has somewhat similar proportions but lacks the axial sculpture on the early spire whorls. In addition *S. lampra* is smaller than *S. gurabensis* and the profile of its whorls is almost straight, whereas in *S. gurabensis* it is somewhat convex.

S. anomala (Gardner and Aldrich, 1919) from the late Miocene Duplin Marl of North Carolina is a smaller and stouter species. It has fewer whorls, but like *S. gurabensis* its early spire whorls carry axial sculpture. Gardner (1948, p. 232, pl. 30, fig. 32) recorded *S. anomala* also from the late Miocene Duplin Marl of South Carolina and compared it with *S. gurabensis,* which she erroneously cited as occurring in the Gurabo Formation of the Dominican Republic. According to Maury (1917a, p. 96), *S. gurabensis* only occurs in her

"Zone G", which is part of the Cercado Formation (Maury, 1917b, table).

S. sincola Olsson, 1922 from the "Miocene" of Costa Rica is a smaller species and its axial sculpture is not restricted to the early spire whorls but extends down to the penultimate whorl.

Occurrence.—*S. gurabensis* occurs only in the section of the Río Gurabo. It has been found at the following localities: NMB 15896, 15897, 15900, 15903, 15904, 15906, 15907, 15910, 15911, 15912, 15913, 15914, 15915, 15916. All these localities are situated in the upper part of the Cercado Formation just below the unconformity marking the base of the Gurabo Formation (Saunders, Jung, and Biju-Duval, 1986, text-fig. 4). The thickness of the sediments containing *S. gurabensis* is a little more than 50 m.

Distribution.—So far *S. gurabensis* is not known outside the Dominican Republic.

Strombina (Sincola) pseudohaitensis (Maury)
Plate 5, figures 1–9; Plate 6, figures 8–16;
Text-figures 8–11

Columbella (*Strombina*) *pseudohaitensis* Maury, 1917a, p. 95, pl. 15, figs. 12, 13.

Description.—Shell of small size, rather stout. Protoconch smooth, consisting of a little more than three volutions, not counting the sinusigerous outer lip. Five-and-one-half to six postnuclear whorls. The first three postnuclear whorls are always sculptured by 14 to 16 orthocline axial riblets per whorl. The axial sculpture may continue after the first three postnuclear whorls; if so, the axial ribs are less prominent and gradually become prosocline. On the body whorl the axial ribs are always absent. Spire whorls shouldered, their profile straight to slightly convex. Body whorl convex, smooth except for growth lines and spiral cords near the base. Outer lip thickened, with a varying number of weak, moderately prominent or heavy denticles on its inner surface. Parietal callus moderately prominent.

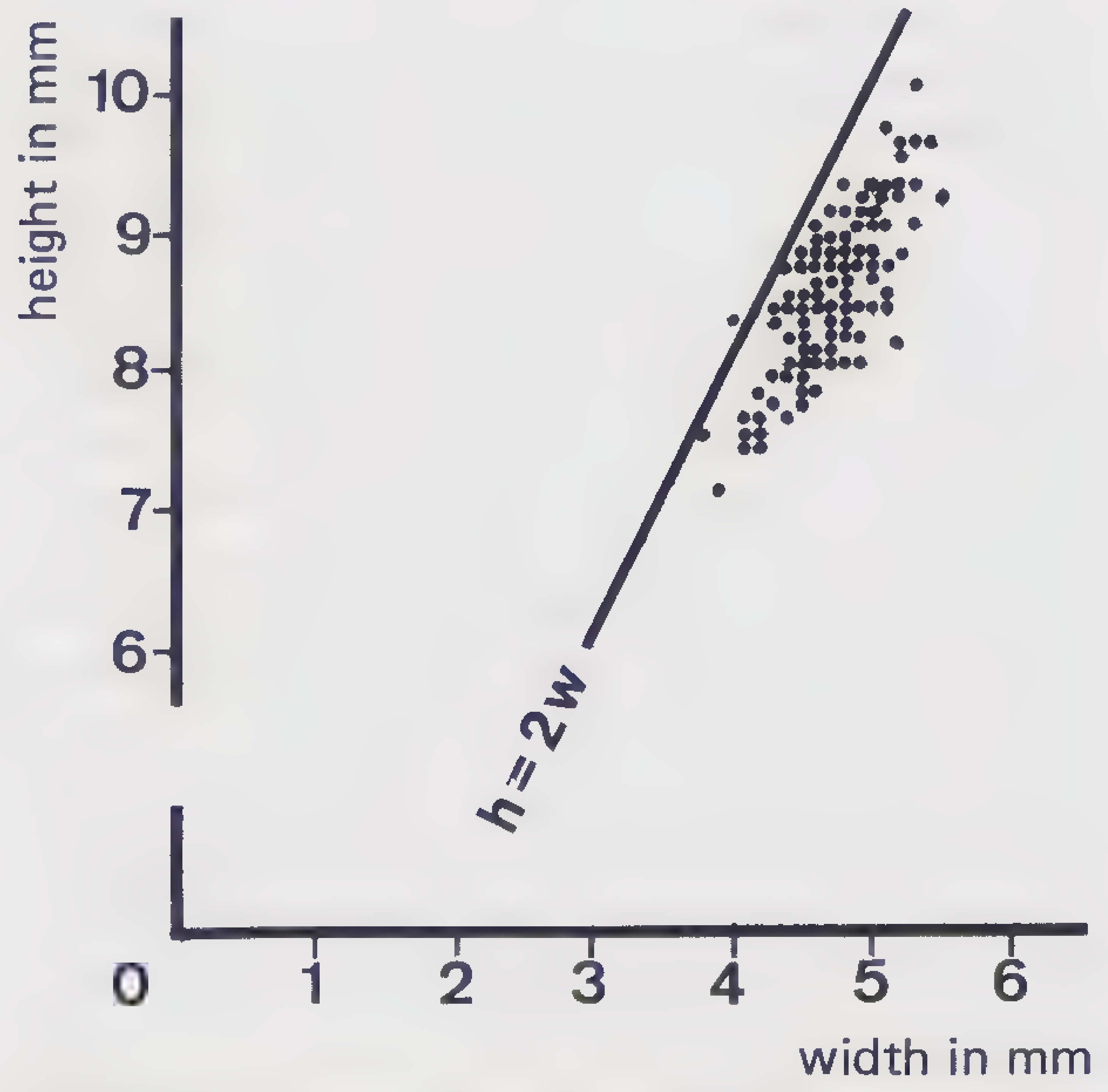
Lectotype (herein selected).—PRI 28733. This specimen has been figured by Maury (1917a, pl. 15, fig. 12) and is refigured here (see Pl. 5, figs. 1–3). The only paralectotype (PRI 30582) has also been figured by Maury (1917a, pl. 15, fig. 13) and is refigured here (Pl. 5, figs. 4–6).

Dimensions of lectotype.—Height: 8.8 mm; width: 5.1 mm.

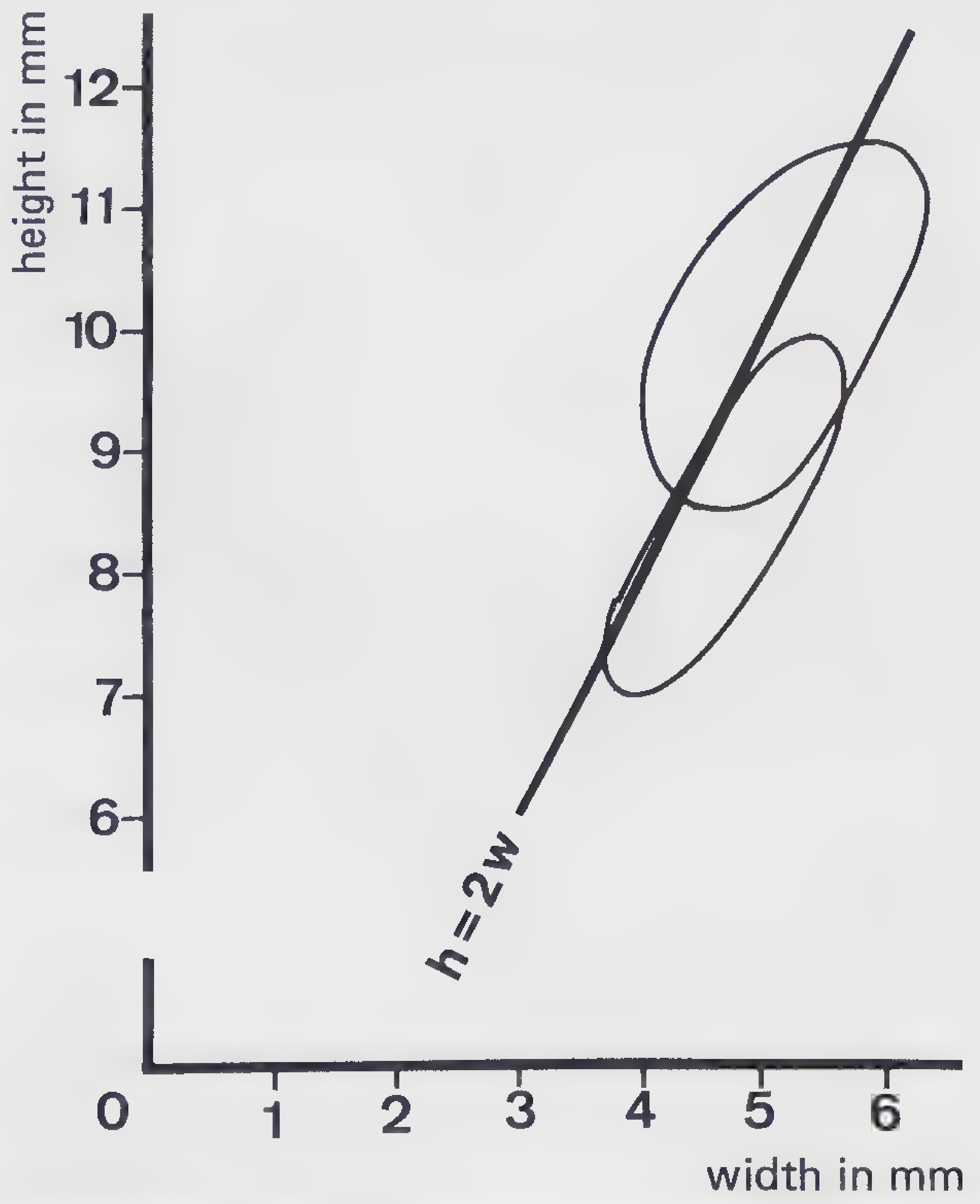
Type locality.—Cercado de Mao: Bluff 3 of Maury on Río Mao, Dominican Republic. In order to be more precise the type locality is here restricted to NMB locality 16913 (Saunders, Jung, and Biju-Duval, 1986, text-fig. 29).

Material.—This species is represented by about 1000 well-preserved specimens. The type locality has yielded about 120 specimens.

Measurements.—In the height/width diagram of Text-figure 8 the measurements of "populations" of 50 adult individuals from NMB localities 16913, 16923, and 16927 (Saunders, Jung, and Biju-Duval, 1986, text-fig. 29) have been plotted. The three "populations" have not been marked individually in Text-figure 8 as



Text-figure 8.—Height/width diagram of *S. pseudohaitensis* with line indicating heights corresponding to two widths (h = 2w).



Text-figure 9.—The two fields of size variability of *S. gurabensis* (larger field) and *S. pseudohaitensis* with line indicating heights corresponding to two widths (h = 2w).

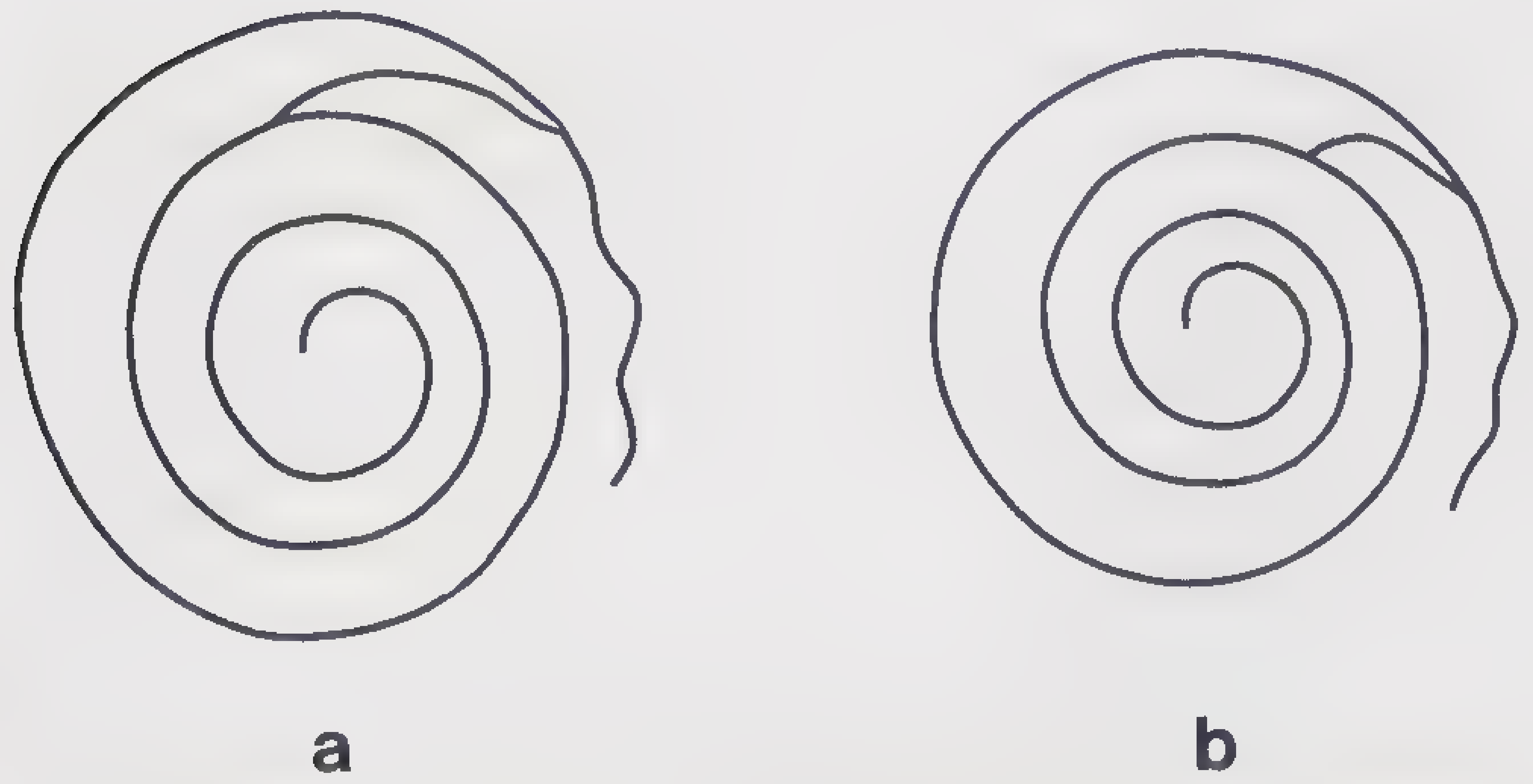
they do not show different patterns. The line indicating height corresponding to two widths (h = 2w) lies on one side of the field of size variability, *i.e.,* the width of the specimens is more than half the total height of the shell.

Remarks.—*S. pseudohaitensis* is somewhat variable in its development of the axial sculpture and the strength of the denticles on the inner surface of the outer lip.

S. pseudohaitensis mainly occurs in thin bands largely consisting of molluscs, and in shell beds interbedded with silts, but it has also been found scattered in silts.

Maury included *Planaxis crassilabrum* Guppy, 1874, in the synonymy of her *S. pseudohaitensis,* stating that Guppy had described a young specimen. Guppy's figure is indeed so bad that it does not allow for the recognition of details. However, *S. crassilabrum* is a distinct species of the subgenus *Sincola* in Trinidad (Jung, 1969, p. 508, pl. 53, figs. 14–20).

Comparisons.—*S. pseudohaitensis* is closely related to *S. gurabensis.* It differs from *S. gurabensis* in being stouter; its axial sculpture differs in details of its development and covers more spire whorls. On an average there are more axial ribs per whorl in *S. pseudohaitensis,* and *S. pseudohaitensis* is smaller than *S. gurabensis,* although Text-figure 9 shows some overlap of the two fields of size variability. In addition there seem to be some differences in the development of the protoconch of the two species. Text-figure 10 shows apical views of the protoconch of both species. The protoconch of *S. pseudohaitensis* has slightly more whorls, but at the same time has a somewhat smaller initial whorl than that of *S. gurabensis.* Furthermore the largest diameter of the protoconch of *S. pseudohaitensis* is larger than that of *S. gurabensis.* The position of the two specimens of Text-figure 10 is admittedly not analogous, but this does not change the fact that the protoconch of *S. pseudohaitensis* is stouter than that of *S. gurabensis.*

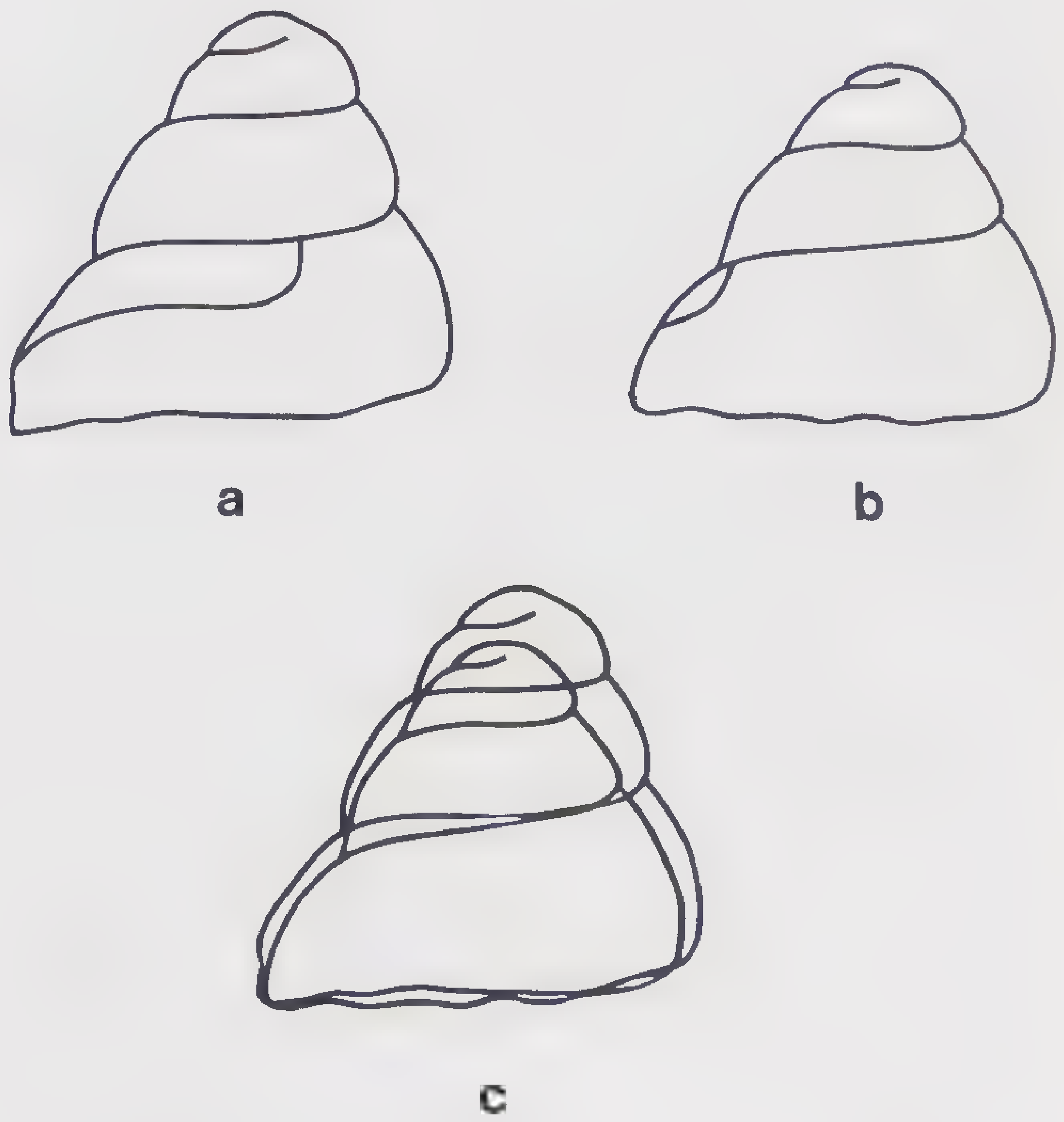


Text-figure 10.—Apical views of the protoconchs of *S. gurabensis* (**a**) and *S. pseudohaitensis* (**b**). **a.** from NMB locality 15914 (Río Gurabo); ×60 (see Pl. 6, fig. 4; NMB H 17022). **b.** from NMB locality 16913 (Río Mao); ×60 (see Pl. 6, fig. 8; NMB H 17027).

The well-rounded body whorl of *S. pseudohaitensis* is somewhat similar to that of *S. harbisonae* Olsson, 1964, from the Angostura Formation (middle Miocene according to Olsson) of northwestern Ecuador. *S. harbisonae* carries axial sculpture on most of the spire whorls like *S. pseudohaitensis,* but it is larger and tends to have more postnuclear whorls. Olsson described the protoconch as consisting of about two smooth whorls. I have examined the holotype of *S. harbisonae* (USNM 644034) and noted that its protoconch consists of at least three whorls, although counting is difficult, because the initial whorl is not well preserved.

Occurrence.—*S. pseudohaitensis* occurs only in the lower part of the section of Río Mao. It has been found at the following localities: NMB 16912, 16913, 16914, 16915, 16916, 16917, 16918, 16922, 16923, 16924, 16926, 16927, 16928, 16929, 16930, 16931, 16932, 17269, and TU 1294. All these localities are situated between Maury's Bluffs 2 and 3 (Saunders, Jung, and Biju-Duval, 1986, text-fig. 29). The beds with *S. pseudohaitensis* probably are of about the same age as those carrying *S. gurabensis.*

Distribution.—So far *S. pseudohaitensis* is not known outside the Dominican Republic.



Text-figure 11.—Side views of the protoconchs of *S. gurabensis* (**a**) and *S. pseudohaitensis* (**b**). **a.** from NMB locality 15912 (Río Gurabo); ×60 (see Pl. 6, fig. 2; NMB H 17019). **b.** from NMB locality 16913 (Río Mao); ×60 (see Pl. 6, fig. 13; NMB H 17029). **c.** overlay of **a** and **b** to show difference in size and proportions.

Strombina (Sincola) caribaea Gabb
Plate 7, figures 1–12; Plate 8, figures 1–7;
Text-figures 12, 13

Strombina caribaea Gabb, 1873, p. 221; Maury, 1917a, p. 98, pl. 15, fig. 6; Pilsbry, 1922, p. 350, pl. 18, fig. 9.
Strombina caribaea micra Pilsbry*, 1922, p. 351, pl. 18, figs. 10, 11.
Not *Strombina caribaea* Gabb. Woodring, 1928, p. 284, pl. 17, fig. 5.

Description.—Shell small and stout. Protoconch smooth, consists of two-and-one-half whorls not counting the sinusigerous outer lip. Postnuclear whorls six, smooth except for faint, almost orthocline growth lines. Spire whorls somewhat convex in profile and slightly shouldered. Body whorl moderately inflated, with a more or less well-developed, broad dorsal hump, and a narrower hump on its left side. Base of body whorl sculptured by about six strong spiral cords. Outer lip greatly thickened, with a few denticles on its inner surface. Parietal callus well developed. Posterior end of aperture usually somewhat channeled. Columella with a few elongated denticles.

Lectotype of S. caribaea.—ANSP 3996. Pilsbry (1922, p. 429, pl. 18, fig. 9) selected and figured the lectotype (refigured here: Pl. 7, figs. 4–6).

Dimensions of lectotype of S. caribaea.—Height: 10.2 mm; width: 5.2 mm.

Type locality of S. caribaea.—A type locality has never been selected; it is here restricted to NMB locality 17288 which is situated within the section south of the village of López on Río Yaque del Norte, north of the village of Baitoa (Saunders, Jung, and Biju-Duval, 1986, text-figs. 21, 25).

Holotype of S. caribaea micra.—ANSP 2800. The only specimen of the type lot is refigured here (Pl. 7, figs. 1–3).

Dimensions of holotype of S. caribaea micra.—Height: 5.8 mm; width: 2.7 mm.

Type locality of S. caribaea micra.—A type locality has never been selected; it is here restricted to NMB locality 17288 (see Saunders, Jung, and Biju-Duval, 1986, text-figs. 21, 25).

Material.—*S. caribaea* is represented by about 300 specimens. Most of these specimens have been collected at NMB locality 17286 but many of these are incomplete and not very well preserved. The type locality has yielded only about 20 well-preserved specimens.

Measurements.—The dimensions of a number of complete specimens are plotted in Text-figure 12.

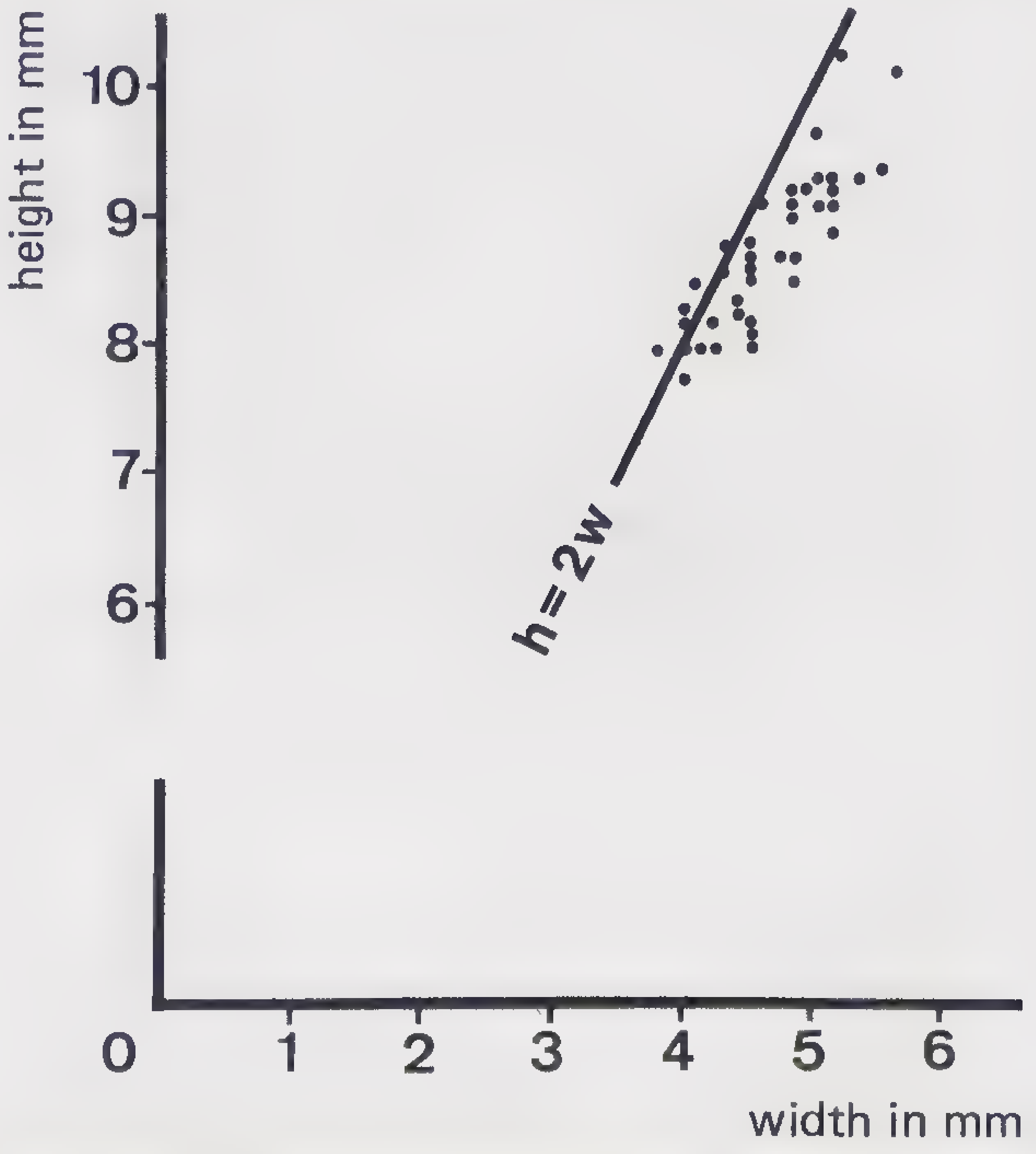
Remarks.—The type lot of *S. caribaea* consists of six specimens, three of which are incomplete. The holotype of *S. caribaea micra* is an immature *S. caribaea*; it has only five postnuclear whorls instead of six and therefore lacks the dorsal hump on its last whorl (see Pl. 7, fig. 2).

The record of *S. caribaea* from the early Pliocene Bowden Formation of Bowden, Jamaica, is based on a single specimen (USNM 369458) (Woodring, 1928, p. 284, pl. 17, fig. 5). Its protoconch is said to consist of one-and-one-half whorls; Dominican specimens on the other hand have a protoconch with two-and-one-half whorls (see also Text-fig. 13). Woodring mentioned additional differences. I have not seen the specimen from Bowden but it obviously represents some other species.

S. caribaea has mostly been found scattered in silts and more rarely in sands, but it has also been collected from conglomeratic layers and from shell beds dominated by *Turritella.*

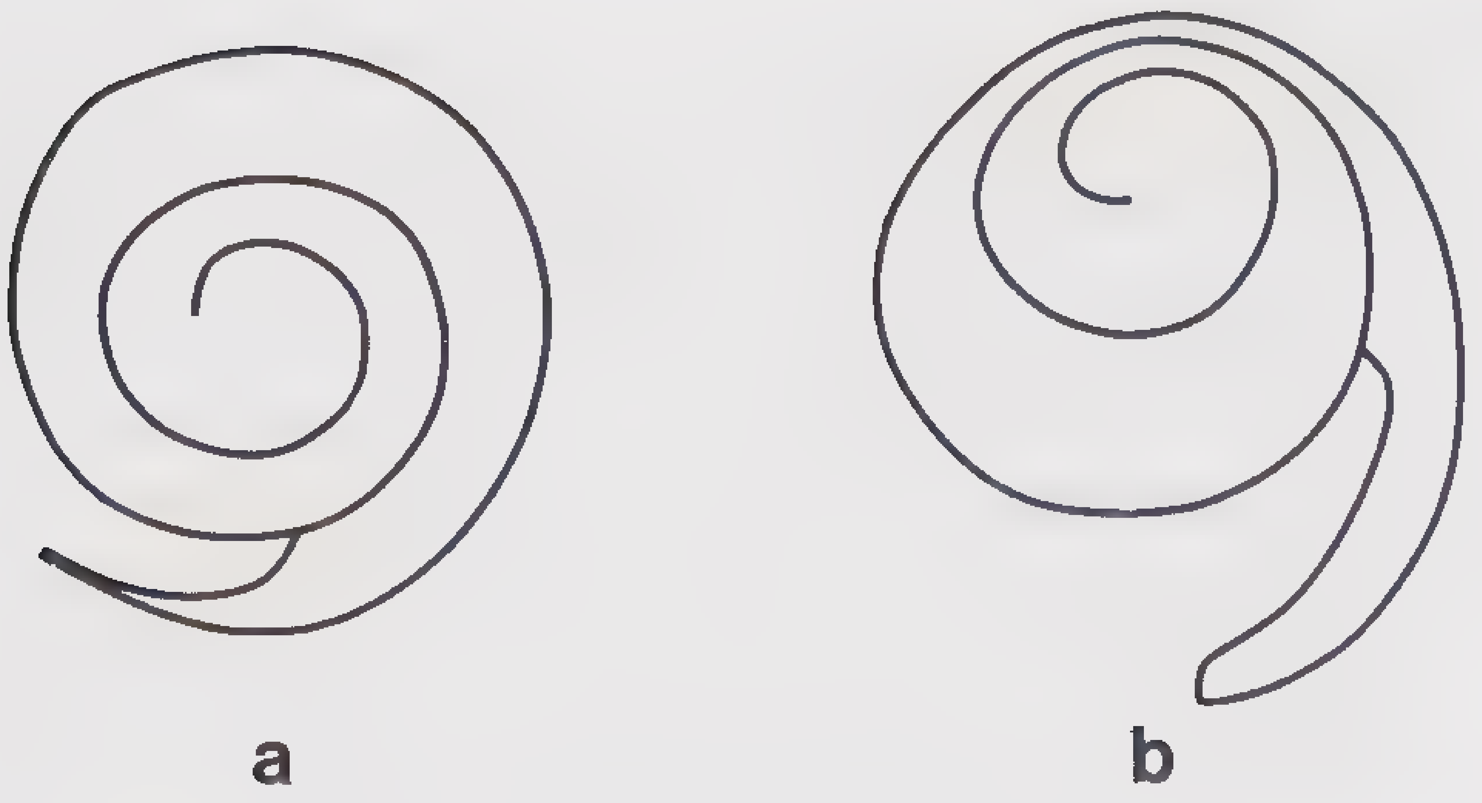
Comparisons.—The Recent Eastern Pacific species *S. gibberula* (G. B. Sowerby I, 1832) is similar to *S. caribaea* but considerably larger. Both species lack sculpture on the spire whorls. In contrast to *S. caribaea, S. gibberula* has no or only weak indications of denticles on the inner surface of its outer lip. This latter feature, however, does not seem to be significant taxonomically as shown by the variability in other species of the subgenus *Sincola.*

S. galvestonensis (Harris, 1895), from the "Deep Well at Galveston", Texas, has axial sculpture on the early spire whorls. Harris stated that the axial ribs are "very rarely as strong as indicated in the figure". The age of



Text-figure 12.—Height/width diagram of *S. caribaea* with line indicating heights corresponding to two widths (h = 2w).

* *S. caribaea micra* was ascribed to Pilsbry *and Johnson* [italics mine] in the explanation of plate 18. P.J.

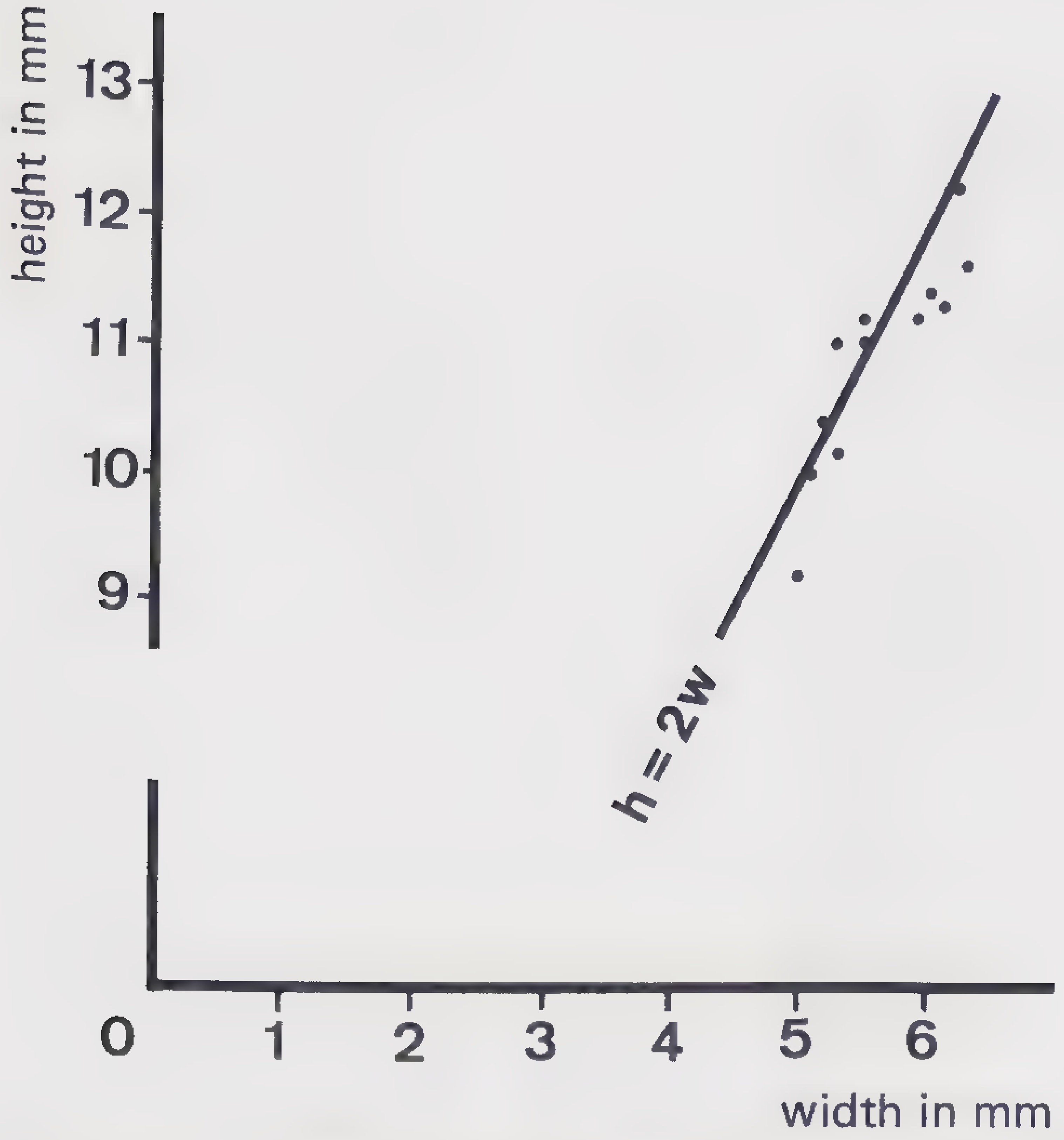


Text-figure 13.—Protoconch of *S. caribaea* from NMB locality 17288 (Río Yaque del Norte); ×70. **a.** apical view (see Pl. 8, fig. 7; NMB H 17034). **b.** oblique apical view of same specimen (see Pl. 8, fig. 6).

the beds carrying *S. galvestonensis* is given as late Miocene.

Occurrence.—*S. caribaea* only occurs in the section south of the village of López on Río Yaque del Norte, *i.e.*, north of the village of Baitoa (Saunders, Jung, and Biju-Duval, 1986, text-figs. 21, 25). It has been collected at the following localities: NMB 16936, 16938, 16942, 17283, 17284, 17285, 17286, 17287, 17288, 17289. All these localities fall in the Baitoa Formation.

Distribution.—So far *S. caribaea* is not known from outside the Dominican Republic.



Text-figure 14.—(Restored) height/width diagram of *S. bassi* with line indicating heights corresponding to two widths (h = 2w).

Strombina (Sincola) bassi (Maury)
Plate 8, figures 8–14; Plate 9, figures 1–6;
Text-figures 14, 15

Columbella (Strombina) bassi Maury, 1917a, p. 96, pl. 15, fig. 17.

Description.—Shell of medium size, moderately slender. Protoconch consists of slightly less than two-and-one-half smooth whorls not counting the sinusigerous outer lip. Up to six-and-one-half postnuclear whorls. Profile of spire whorls straight to slightly convex. Axial sculpture prominent. Axial ribs orthocline to slightly prosocline. There are 13 to 17 axial ribs on early spire whorls and 15 to 21 axial ribs on the penultimate whorl. Spire whorls somewhat shouldered; on the body whorl the shoulder is accentuated by a spiral cord. Axial ribs absent on last half of body whorl. Base of body whorl sculptured by a varying number of spiral cords. Outer lip thickened, with denticles on its inner surface. Parietal callus moderately prominent. Columella with a varying number of denticles.

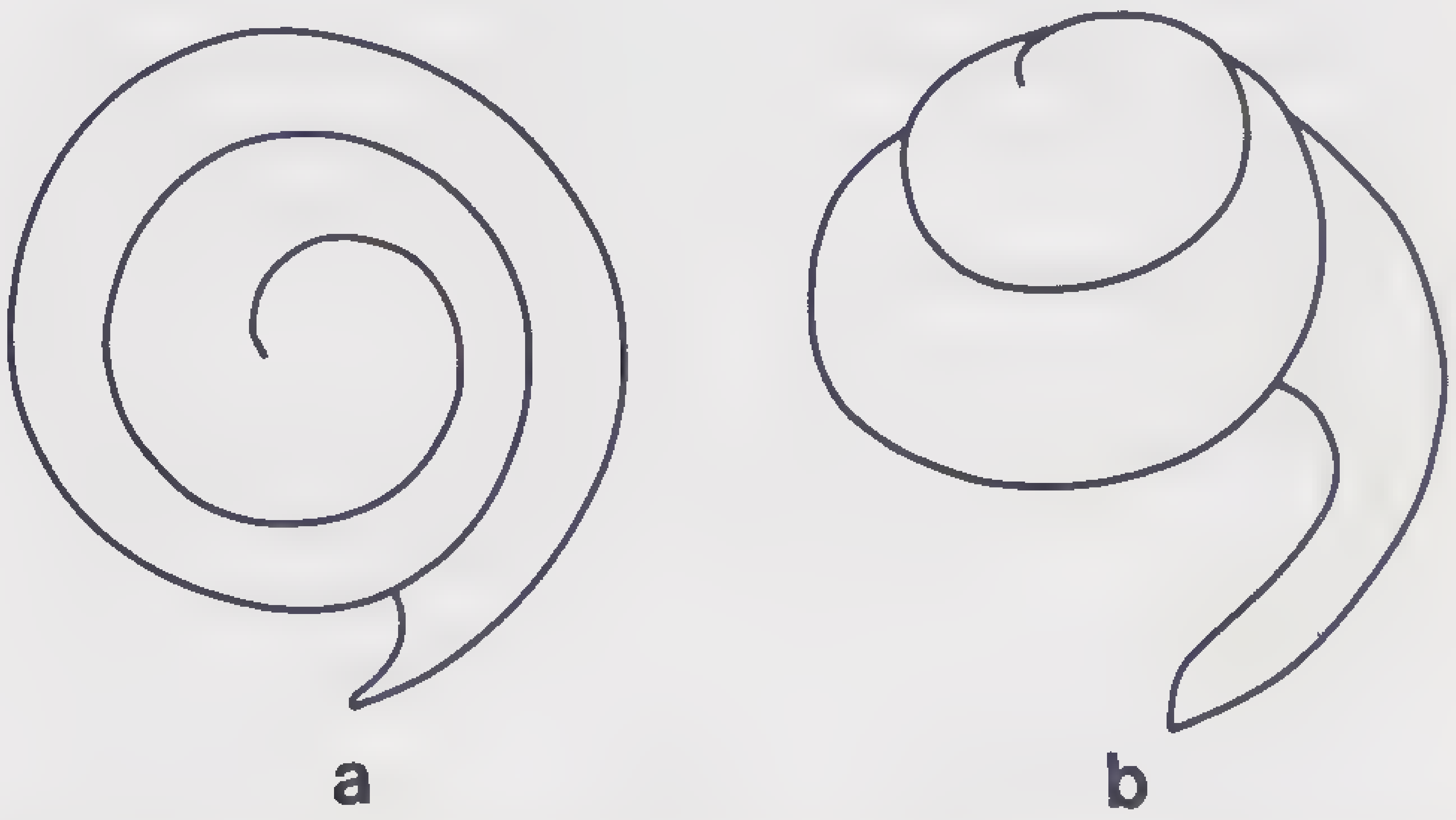
Holotype.—PRI 28736 (refigured here: Pl. 9, figs. 1–3).

Dimensions of holotype.—Height: 11.0 mm; width: 5.3 mm.

Type locality.—Río Gurabo at Los Quemados, Dominican Republic; Maury's Zones D and E. It does not seem advisable to select a more precise type locality, because our collections do not contain *S. bassi* from Maury's Zones D and E, which extend from the bridge of the Los Quemados–Santiago Rodriguez road upstream (southward) over an airline distance of a little more than 2 km. Zones D and E include parts of the Gurabo Formation (Maury, 1917b).

Material.—This species is represented by about 70 specimens, many of which are immature or have a broken apex.

Measurements.—The dimensions of the specimens that can be measured with reasonable accuracy are plotted in Text-figure 14.



Text-figure 15.—Protoconch of *S. bassi* from NMB locality 16856 (Río Cana); ×70. **a.** apical view (see Pl. 8, fig. 14; NMB H 17092). **b.** oblique apical view of same specimen (see Pl. 8, fig. 12).

Remarks.—This species is variable as to prominence and number of the axial ribs on the spire whorls. According to Maury this species occurs only in the section of Río Gurabo. The material at hand is partly from Río Gurabo but also from the section along Río Cana. In fact the best preserved protoconchs (Text-fig. 15; Pl. 8, figs. 8–14) are from Río Cana.

S. bassi usually occurs scattered in silts. Some specimens from Río Cana have been found associated with large numbers of *Arca patricia* Sowerby, 1850. Many but not all of the shells from Río Cana are smaller than those from Río Gurabo.

Comparisons.—*S. gunteri* Mansfield, 1930, from the late Miocene Choctawhatchee Formation and the Pliocene of North St. Petersburg, Florida (Olsson and Harbison, 1953) is more slender and somewhat smaller than *S. bassi.* Both species lack axial sculpture on the last part of their body whorls. The protoconch of *S. gunteri* is said to consist of three whorls. When I examined the holotype of *S. gunteri* its protoconch was no longer preserved. *S. gunteri leonensis* Mansfield, 1930, had been collected from about the same level as *S. gunteri*; it most probably is an immature *S. gunteri.*

The proportions of *S. lloydsmithi* Pilsbry and Brown, 1917, from beds of uncertain age (Miocene?) of northern Colombia are similar to those of *S. bassi.* Like *S. bassi, S. lloydsmithi* lacks axial ribs on the last part of the body whorl except for one axial rib behind the thickened outer lip; but its body whorl is sculptured by prominent spiral grooves from base to suture except on and just before the dorsal hump. When examining the holotype and only specimen of *S. lloydsmithi* I noticed that its protoconch is broken off. According to the original description it consisted of three whorls.

Another species lacking axial ribs on the last part of its body whorl is *S. cunninghamcraigi* (Rutsch, 1942) from the late Miocene Savaneta glauconitic sandstone Member of the Springvale Formation of Trinidad. The holotype (NMB H 6177) and many topotypes are available for comparison. It is smaller than *S. bassi* and has fewer postnuclear whorls. Its protoconch consists of more than three whorls and its siphonal fasciole is somewhat swollen.

Occurrence.—*S. bassi* occurs in the sections of Río Gurabo and Río Cana and has been collected from the following localities. Río Gurabo: NMB 15882, 15899, 15902; Río Cana: NMB 16841, 16848, 16854, 16855, 16856, 16857, 17001, and TU 1230. Most of the specimens from Río Gurabo have been found in the top part of the Cercado Formation (NMB locs. 15899, 15902) and only the two specimens (NMB H 17145) found at NMB locality 15882 come from the lower part of the Gurabo Formation. All the material from Río Cana is from the upper part of the Cercado Formation with the exception of a single specimen (NMB H 17146) from the Gurabo Formation (NMB loc. 16869) which has been identified as *S.* aff. *bassi.* This specimen is larger and more slender than the others and carries axial ribs also on the last part of its body whorl.

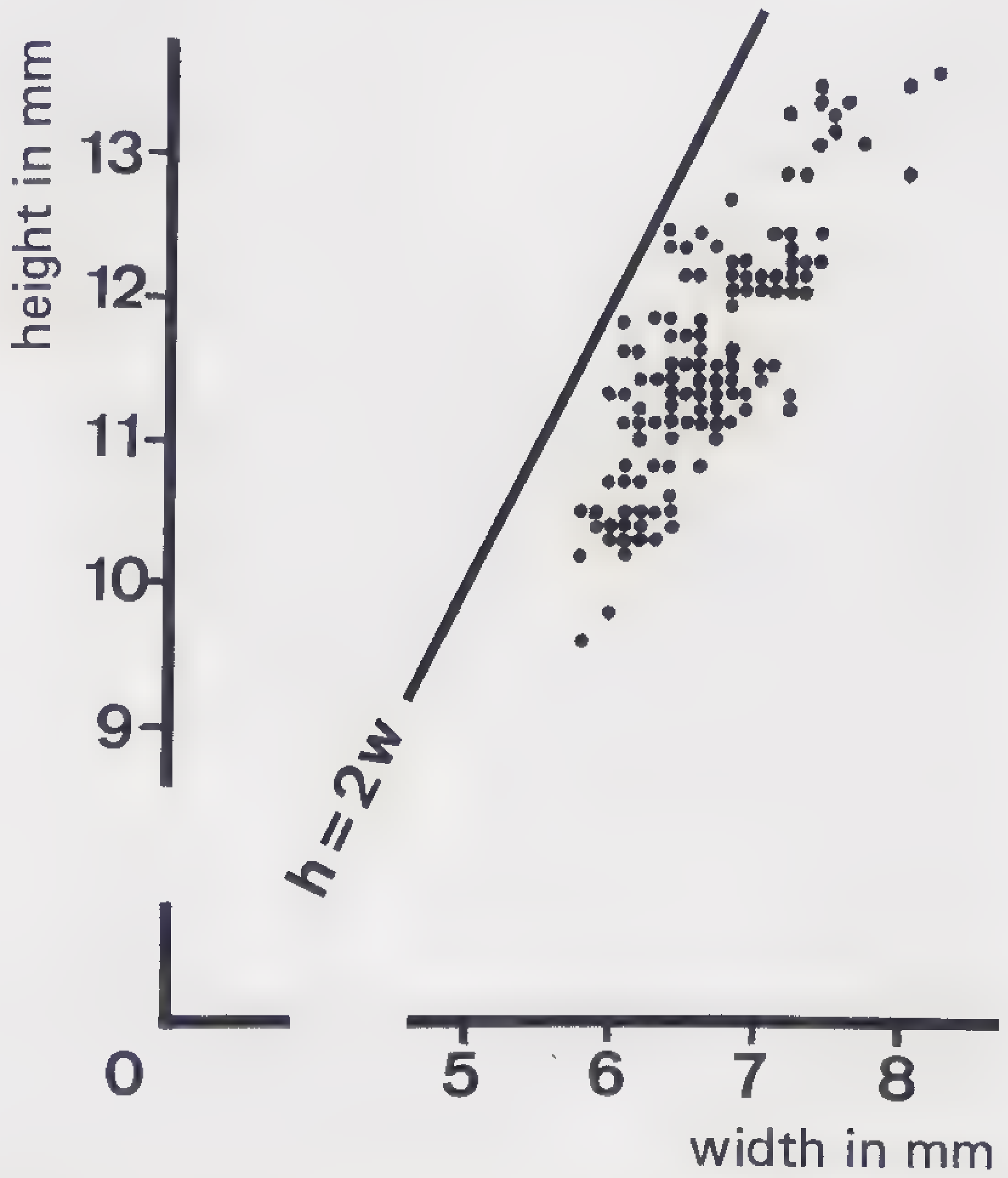
Distribution.—So far *S. bassi* is not known from outside the Dominican Republic.

Strombina (Sincola) nanniebellae (Maury)
Plate 10, figures 1–13; Plate 11, figures 1–9;
Text-figures 16, 17

Columbella (*Strombina*) *nanniebellae* Maury, 1917a, p. 96, pl. 15, figs. 15, 16.

Description.—Shell of medium size, stout. Protoconch consists of three smooth volutions not counting the sinusigerous outer lip. Up to six-and-one-half postnuclear whorls. The first one or two postnuclear whorls sculptured by orthocline axial ribs numbering 13 to 15 per whorl. Remaining spire whorls smooth except for prosocline growth lines. Profile of spire whorls somewhat convex. Body whorl inflated, almost circular in cross-section, sculptured by spiral cords near the base and a more or less prominent spiral cord adjoining the suture. Outer lip thickened, with no or only a few denticles on its inner surface. Parietal wall with a callous thickening near the adapical end of the aperture.

Lectotype (herein selected).—PRI 28735. This is the specimen figured by Maury (1917a, pl. 15, fig. 15). There is only one paralectotype (PRI 30583). The lectotype is refigured here (Pl. 10, figs. 1–3).



Text-figure 16.—(Restored) height/width diagram of *S. nanniebellae* with line indicating heights corresponding to two widths (h = 2w).

Dimensions of lectotype.—Height: 12.4 mm; width: 6.8 mm.

Type locality.—Río Cana at Caimito, Dominican Republic, Maury's Zones H and I. The type locality is here restricted to NMB locality 16856, which is situated 2.5 km upstream from the old bridge of the Los Quemados–Santiago Rodriguez road at Caimito. This locality is in the Cercado Formation (Saunders, Jung, and Biju-Dival, 1986, text-fig. 15).

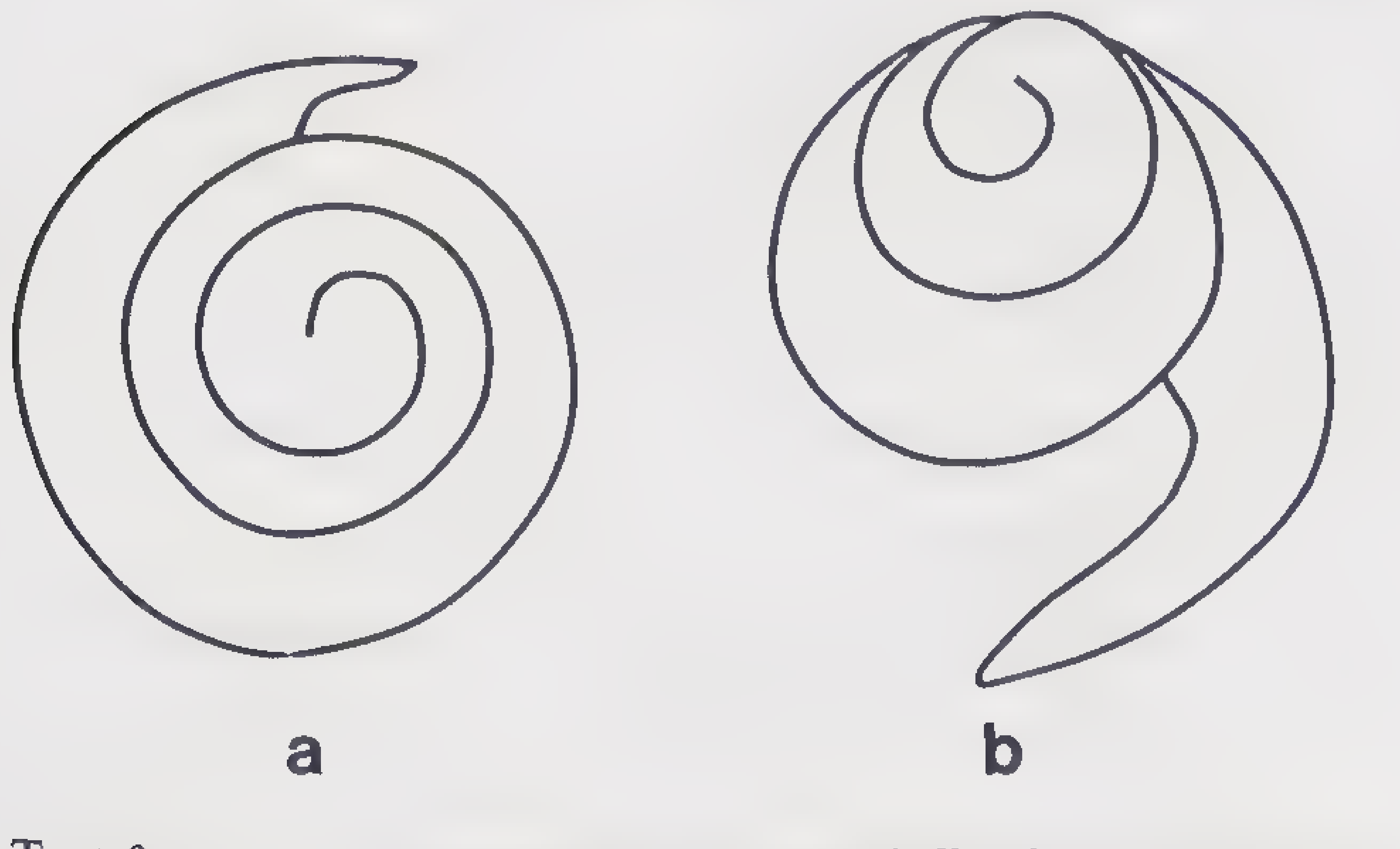
Material.—As stated by Maury this species is abundant. There are a little more than 1000 specimens in our collections, most of them well preserved, but many incomplete. The type locality has yielded 120 specimens.

Measurements.—The dimensions of a number of specimens have been plotted in Text-figure 16. No significant differences in size were found in different "populations". The line indicating heights corresponding to two widths (h = 2w) lies on one side of the field of size variability, *i.e.,* the width of the specimens is always more than half the total height of the shells.

Remarks.—The development of the axial sculpture of *S. nanniebellae* is quite variable. Usually the first two postnuclear whorls carry axial ribs, but in some specimens they are restricted to the first postnuclear whorl; in other cases they extend over the first three postnuclear whorls. On certain specimens the axial sculpture may be almost missing. In fact the type locality has yielded many specimens with practically no axial ribs. On the other hand there are shells with axial wrinkles on parts of their body whorls. In those cases a low and broad dorsal hump is usually developed.

The outer lip of *S. nanniebellae* is usually smooth on its inner surface, but a few inconspicuous denticles may be developed. The parietal callus is only prominent near the adapical end of the aperture.

The protoconch is unsculptured and consists of three whorls (Text-fig. 17). The length of its sinusigerous outer lip seems to be constant. There is one specimen from NMB locality 16839 with a protoconch consisting of only two-and-three-quarters whorls (see Pl. 11, fig. 9). Does this mean that the number of protoconch whorls is not quite constant in a given species?



Text-figure 17.—Protoconch of *S. nanniebellae* from NMB locality 16856 (Río Cana). **a.** apical view (see Pl. 11, fig. 5; NMB H 17045); ×70. **b.** oblique apical view of same specimen (see Pl. 11, fig. 4); ×65.

S. nanniebellae mainly occurs in silts, be it scattered or concentrated in lenses or individual layers. It has also been found in conglomeratic lenses.

Comparisons.—*S. pigea* Olsson, 1964, from the Angostura Formation (middle Miocene according to Olsson) of northwestern Ecuador is larger and more slender than *S. nanniebellae. S. pigea* has no axial sculpture at all, but the cross-section of the body whorl of both species is similar.

S. pseudohaitensis (Maury, 1917a) (discussed earlier in this paper) is consistently smaller, has a more prominent axial sculpture on its spire whorls, and less convex whorls.

Occurrence.—This species occurs only in the section along Río Cana. It has been found at the following localities: NMB 16834, 16837, 16838, 16839, 16842, 16844, 16853, 16854, 16855, 16856, 16857, 16984, 16986, 16989, 16995, 17003, 17004, and TU 1230, 1282, and 1301. All these localities are situated in the upper part of the Cercado Formation (Saunders, Jung, and Biju-Duval, 1986, text-fig. 15).

Distribution.—So far *S. nanniebellae* is not known from outside the Dominican Republic.

Subgenus **BIFURCIUM** Fischer, 1884

Bifurcium Fischer, 1884, p. 638
Bifurcina Cossmann, 1901, p. 230.

Type species (by original designation and monotypy).—*Columbella bicanalifera* G. B. Sowerby I, 1832. Recent, Eastern Pacific.

Diagnosis.—Shell of small size. General shape ranging from stout to moderately slender. Sculpture predominantly axial. Axial sculpture usually restricted to early spire whorls. Spiral sculpture restricted to base of body whorl. Outer lip thickened, with or without denticles on its inner surface. Outer lip extended adapically, bordering a prominent posterior canal. Anterior canal short and recurved.

Remarks.—This subgenus is represented in the material from the northern Dominican Republic by relatively few specimens. They are assigned to two species.

So far the only species that has been included in *Bifurcium* is its type species, the Recent species *Columbella bicanalifera* G. B. Sowerby I, 1832. It had been dredged in the Galapagos Islands in sandy mud at a depth of 10 fathoms (= 18 m) according to the original description. According to Keen (1971, p. 587) it is known from the southern part of the Gulf of California to Ecuador and the Galapagos Islands. Pilsbry

and Olsson (1941, pp. 8, 35) cited this species (?) under the name *Bifurcium bifurcium* Fischer (a name that does not exist formally, *i.e.*, a *nomen nudum*) from the Pliocene Jama Formation of western Ecuador.

If the species described below are included, the stratigraphic range of *Bifurcium* is late Miocene to Recent.

As mentioned below the protoconchs of *S. nuestrasenorae* are not well preserved, and better specimens are needed to determine the shape of the outer lip. The protoconch of *S. canae* has an opisthocyrt outer lip, which would point to a pelagic-planktotrophic larval life according to Shuto (1974). Whether *S. bicanalifera* has the same type of protoconch remains to be seen.

Strombina (Bifurcium) nuestrasenorae (Maury)
Plate 11, figures 10–12; Plate 12, figures 1–9;
Text-figures 18, 20, 21

Columbella (*Strombina*) *neustrasenorae* [*sic*] Maury, 1917a, p. 98, pl. 15, fig. 11 (*nuestrasenorae* in explanation of plate).
Not *Strombina neustrasenorae* Maury. Woodring, 1928, p. 284.

Description.—Shell small, rather stout. Protoconch smooth, consisting of a little more than two volutions. Five postnuclear whorls. The first two or three postnuclear whorls sculptured by orthocline to slightly prosocline axial ribs. There are 14 to 20 axial ribs per whorl. Later whorls smooth except for faint growth lines. Profile of spire whorls straight to slightly convex. Whorls somewhat shouldered. Body whorl moderately inflated, its shoulder accentuated by a spiral depression. Body whorl with spiral cords near its base and one or two more or less well-developed axial swellings on its left side. Outer lip strongly thickened, extended adapically, with prominent denticles on its inner surface. Parietal callus well developed, with a ridge forming the left border of the posterior canal. Columella with some denticles. Anterior canal recurved.

Holotype.—PRI 28732. This was apparently the only specimen Maury had when she described this species. It is refigured here (see Pl. 12, figs. 4–6).

Dimensions of holotype.—Height: 7.8 mm; width: 4.2 mm.

Type locality.—Río Gurabo at Los Quemados, Dominican Republic; Maury's Zone G. The type locality is here restricted to NMB locality 15882 which falls in the lower part of the Gurabo Formation (Saunders, Jung, and Biju-Duval, 1986, text-fig. 4).

Material.—Maury stated that this is a rare species. Our collections have yielded only 25 specimens, many of which are incomplete and (or) not well preserved. In particular the protoconch is never well preserved, and the shape of its outer lip cannot be determined with certainty (see Pl. 11, fig. 10).

Measurements.—The dimensions of a number of more or less complete specimens are plotted in Text-figure 18.

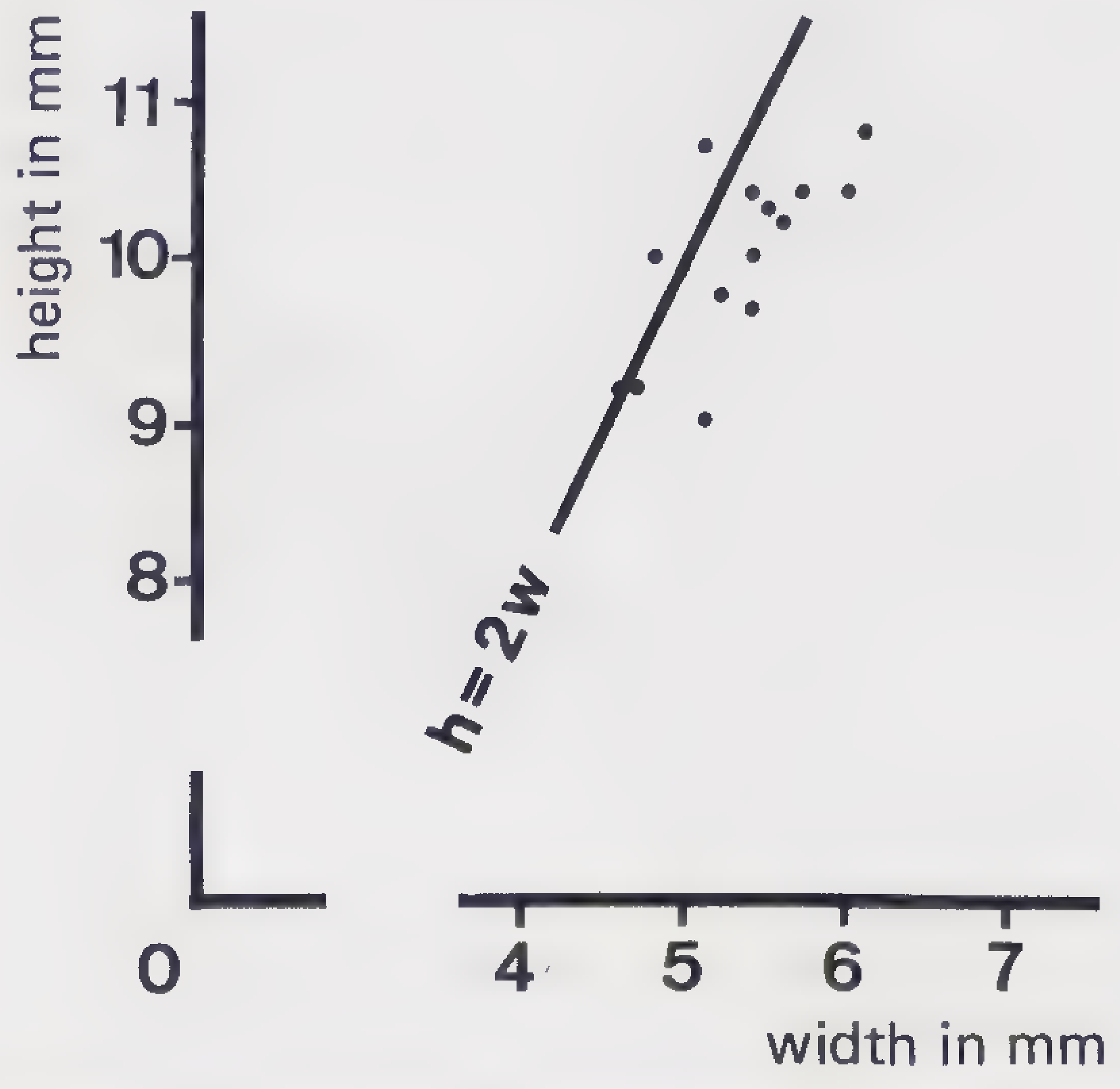
Remarks.—The axial sculpture of this species is variable: it is usually restricted to the first two or three postnuclear whorls but may be faintly developed on the fourth postnuclear whorl as well. The number of axial ribs per whorl is quite variable. The prominence of the axial swellings on the left side of the body whorl influences the general shape of the body whorl.

A single specimen (NMB H 17086) from locality 16856 (Río Cana, Cercado Formation) has a considerably stouter appearance than the other specimens. This is largely due to the two strong axial swellings on the left side of the body whorl. It has been identified as *S.* aff. *nuestrasenorae* (see Pl. 13, figs. 1–3).

S. nuestrasenorae has been found scattered in silts, concentrated in thin shell beds, and in silts with burrows filled with small molluscs.

Comparisons.—The type species of *Bifurcium,* the Recent Eastern Pacific species *S. bicanalifera* (Sowerby, 1832), is more slender and larger than *S. nuestrasenorae.* One of the three syntypes (BMNH 1966312) of *S. bicanalifera* from the Galapagos Islands is figured here for comparison (Pl. 13, figs. 4–9). The protoconch of *S. bicanalifera* consists of three whorls, and there are six postnuclear whorls and not five as in *S. nuestrasenorae.* The outer lip is not as greatly thickened, there are no prominent axial swellings on the left side of the body whorl, and there is no strongly-developed parietal callus. The figured syntype has only weak denticles on the inner surface of the outer lip; in the other two syntypes they are more prominent.

S. canae, n. sp., from the Cercado Formation of Río Cana is described below. It is essentially smaller than



Text-figure 18.—(Restored) height/width diagram of *S. nuestrasenorae* with line indicating heights corresponding to two widths (h = 2w).

S. nuestrasenorae and its axial sculpture is more strongly developed.

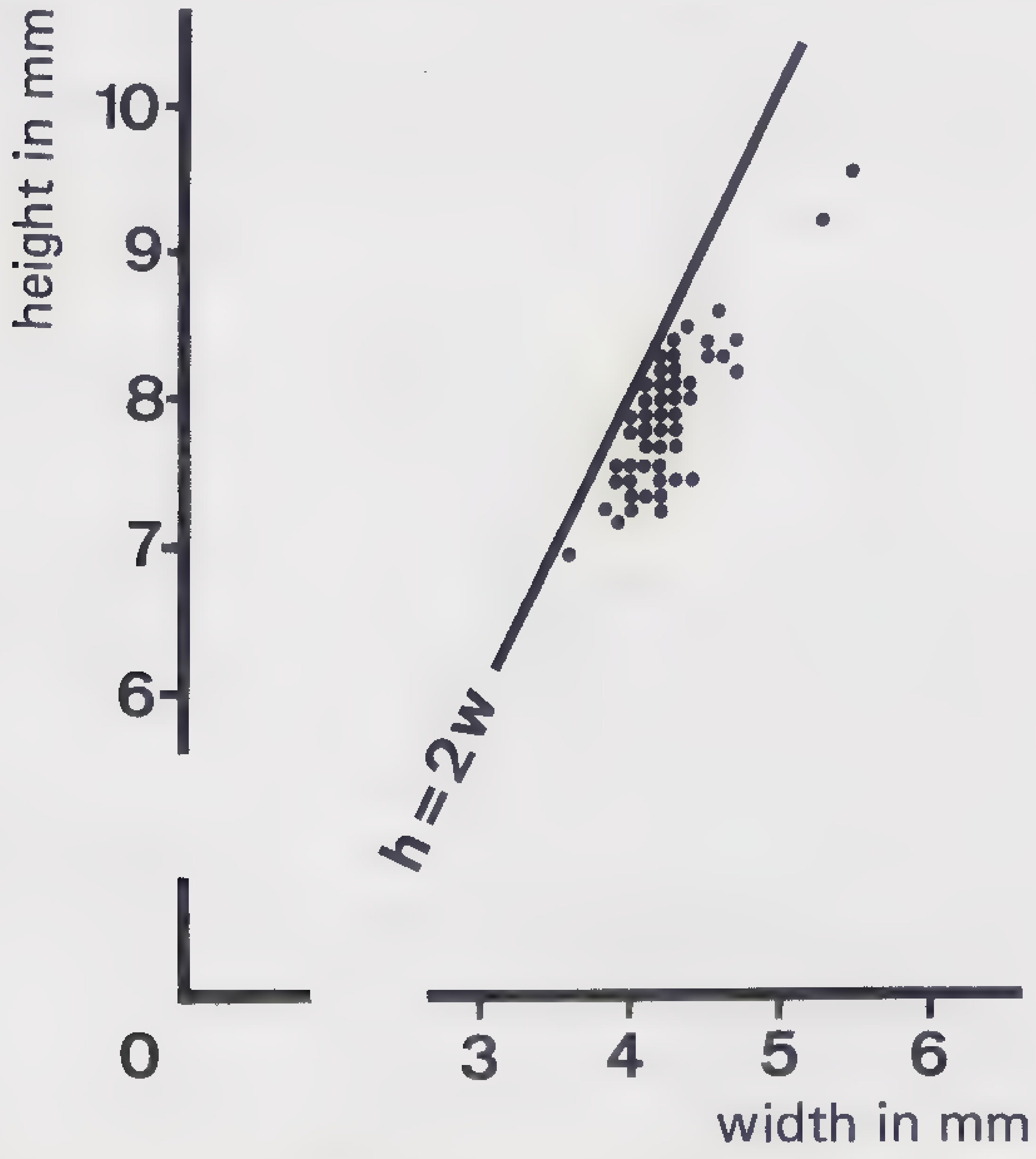
Occurrence.—*S. nuestrasenorae* occurs in the Río Gurabo, Río Cana, and in the Arroyo Zalaya and has been found at the following localities. Río Gurabo: NMB 15869, 15873, 15878, 15882; Río Cana: NMB 16857 (one specimen only); Arroyo Zalaya: TU 1227A (see Saunders, Jung, and Biju-Duval, 1986, text-figs. 4, 15, 36). The specimens from the Río Gurabo section have been found in the lower part of the Gurabo Formation and the single specimen (NMB H 17085; see Pl. 12, figs. 7–9) from the Río Cana section in the Cercado Formation.

Distribution.—So far *S. nuestrasenorae* is not known from outside the Dominican Republic.

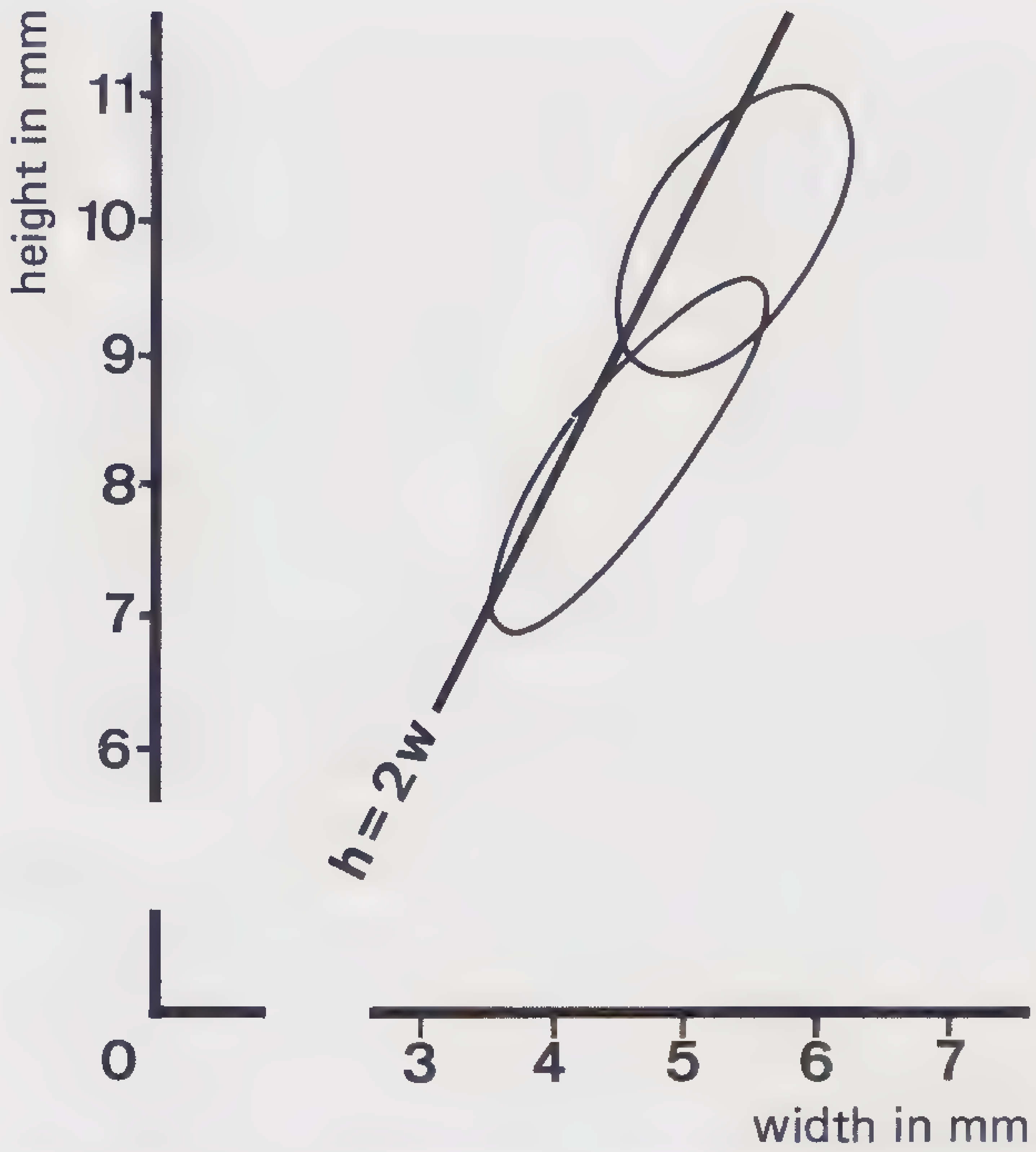
Strombina (Bifurcium) canae, new species
Plate 13, figures 10, 11; Plate 14, figures 1–9;
Text-figures 19–21

Etymology of name.—Named after Río Cana (genitive singular).

Description.—Shell small and stout. Protoconch smooth, consisting of one-and-three-quarters volutions. Five to five-and-one-half postnuclear whorls. Spire whorls straight in profile, sculptured by orthocline axial riblets. Axial sculpture on last spire whorl may be faint. There are 13 to 16 axial ribs per whorl. Outer lip strongly thickened, extended adapically, usually with prominent denticles on its inner surface. Body whorl moderately inflated, with a varying number of spiral cords near its base, and with three conspicuous axial swellings on its left side. Parietal callus well developed, with an axial ridge forming the left margin of the posterior canal. Columella with a few denticles. Anterior canal recurved.



Text-figure 19.—(Restored) height/width diagram of *S. canae* with line indicating heights corresponding to two widths (h = 2w).



Text-figure 20.—The two fields of size variability of *S. nuestrasenorae* (upper field) and *S. canae* with line indicating heights corresponding to two widths (h = 2w).

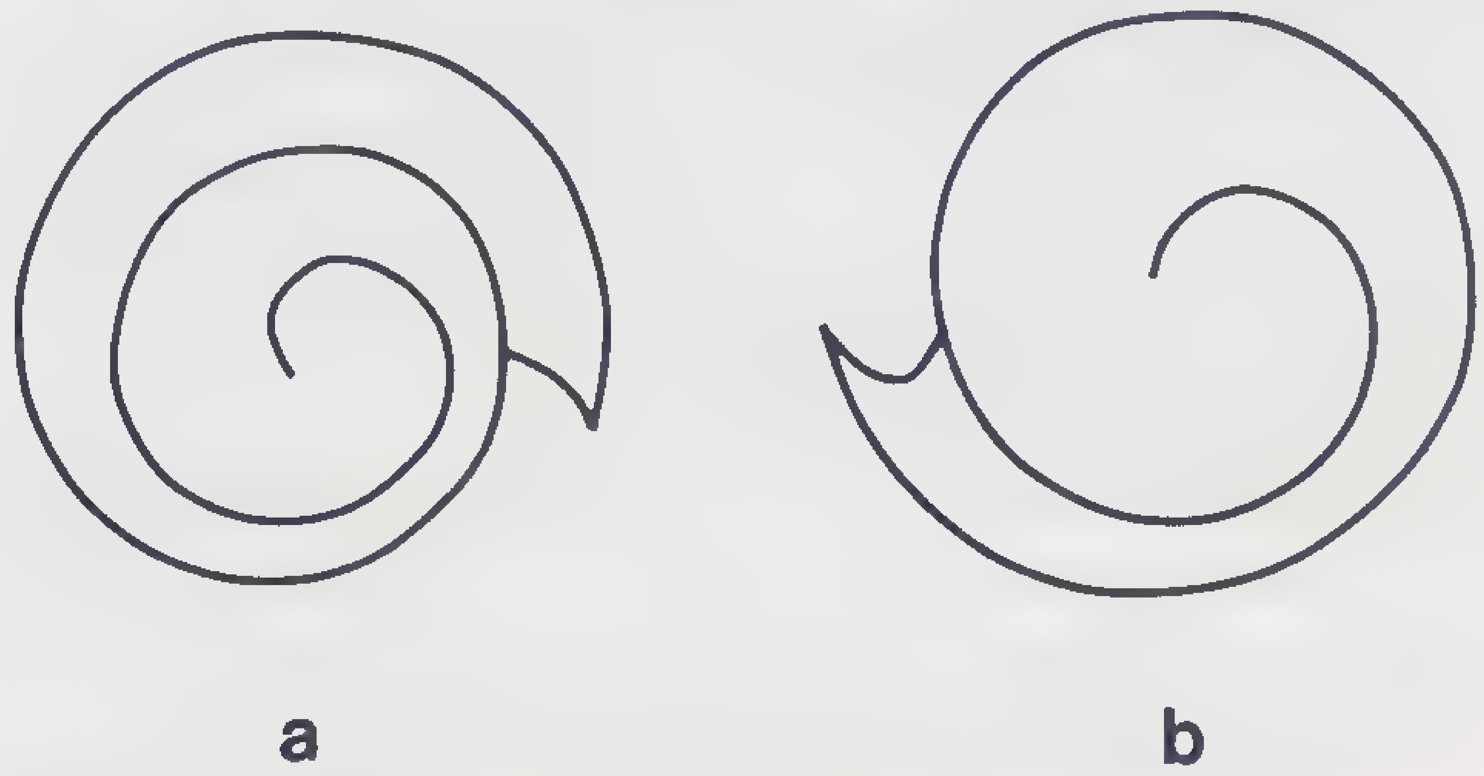
Holotype.—NMB H 17041.

Dimensions of holotype.—Height: 8.1 mm; width: 4.5 mm.

Type locality.—NMB locality 16837: Río Cana, Dominican Republic; upper part of Cercado Formation (Saunders, Jung, and Biju-Duval, 1986, text-fig. 15).

Material.—This species is based on about 160 specimens, many of which are complete and well preserved. The type locality alone has yielded about 140 specimens.

Measurements.—The dimensions of a number of specimens are plotted in Text-figure 19.



Text-figure 21.—Apical views of the protoconchs of *S. nuestrasenorae* (**a**) and *S. canae* (**b**). **a.** from NMB locality 15873 (Río Gurabo); ×60 (see Pl. 11, fig. 12; NMB H 17035). **b.** from NMB locality 16837 (Río Cana); ×65 (see Pl. 13, fig. 11; NMB H 17038). Note that the views on both specimens are not exactly apical, but slightly oblique.

Remarks.—The axial sculpture of *S. canae* is somewhat variable. Although it usually covers all the spire whorls, it may be reduced or even missing on the last and rarely on the last two spire whorls. Whenever the axial sculpture is missing on spire whorls their profile is somewhat convex. The number and strength of the denticles on the inner surface of the outer lip is also variable. On the left side of the body whorl there are usually three axial swellings, but in some specimens there are only two. In some specimens there are additional axial ribs on the front (ventral) side of the body whorl.

S. canae has been found scattered in silts and concentrated in conglomeratic layers, in shelly lenses, and in thin shell beds.

Comparisons.—*S. canae* is obviously closely related to *S. nuestrasenorae*; in fact it looks like a miniature *S. nuestrasenorae.* However *S. canae* is not only smaller than *S. nuestrasenorae* but its proportions are somewhat different: in *S. canae* the width of the shells is always more than half the total height, which is not the case throughout in *S. nuestrasenorae* (see Text-fig. 20). In addition the axial sculpture of *S. canae* covers more spire whorls on an average. In *S. canae* there are usually three axial swellings on the left side of the body whorl, in *S. nuestrasenorae* only two.

Unfortunately the protoconchs of both species are not very well preserved, but it seems that both do not have a sinusigerous outer lip. The protoconch of *S. nuestrasenorae* has a little more than two whorls, that of *S. canae* only one-and-three-quarters. The specimens in Text-figure 21 are shown at slightly different enlargements, but it is still obvious that the initial whorl of *S. canae* is somewhat larger than that of *S. nuestrasenorae.*

S. nuestrasenorae mainly occurs in the lower part of the Gurabo Formation of Río Gurabo, whereas most specimens of *S. canae* have been collected from the upper part of the Cercado Formation of Río Cana.

Occurrence.—*S. canae* has been found at the following localities. Río Cana: NMB 16835, 16836, 16837, TU 1230, 1301; Río Gurabo: NMB 15842 (one specimen only: see Pl. 14, figs. 7–9). The specimens from the Río Cana section have all been found in the upper part of the Cercado Formation and the only specimen from the Río Gurabo section in the Gurabo Formation (Saunders, Jung, and Biju-Duval, 1986, text-figs. 4, 6, 15, 16).

Distribution.—So far *S. canae* is not known from outside the Dominican Republic.

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* See footnote, page 5.

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Explanation of Plate 1

Figure		Page
1–9.	***Strombina (Strombina) cyphonotus*** Pilsbry and Johnson	11

1–3. Lectotype, ANSP 3293; locality not known; specimen figured by Brown and Pilsbry (1911, pl. 25, fig. 6); 1. front view; 2. rear view; 3. from right side. height: 23.5 mm; width: 11.2 mm.

4–6. Paralectotype, ANSP 60173; locality not known; specimen figured by Brown and Pilsbry (1911, pl. 25, fig. 7); 4. front view; 5. rear view; 6. from right side. height: 22.7 mm; width: 11.1 mm.

7–9. PRI 22962; specimen figured by Weisbord (1929, pl. 7, figs. 9, 10) from "between Las Perdices and Pto. Colombia, Dept. of Atlantico", Colombia ("Miocene"); 7. front view; 8. rear view; 9. from right side. height: 20.5 mm; width: 10.4 mm.

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EXPLANATION OF PLATE 2

Figure Page

1–9. ***Strombina (Strombina) prisma*** Pilsbry and Johnson 12

1–3. Lectotype, ANSP 3292; locality not known; specimen figured by Brown and Pilsbry (1911, pl. 25, fig. 10); 1. front view; 2. rear view; 3. from right side. height: 26.0 mm; width: 10.6 mm.

4–6. Paralectotype, ANSP 60174; locality not known; 4. front view; 5. rear view; 6. from right side. Note channeled suture of early spire whorls. height: 25.7 mm; width: 10.0 mm.

7–9. Paralectotype, ANSP 60174; locality not known; specimen figured by Brown and Pilsbry (1911, pl. 25, fig. 9); 7. front view; 8. rear view; 9. from right side. height: 22.8 mm; width: 10.5 mm.

EXPLANATION OF PLATE 3

Figure — Page

1–3. ***Strombina (Spiralta) maculosa*** (G. B. Sowerby I) 13
BMNH 1982136; syntype. "Guacamayo, Central America, sandy mud, 10 fathoms"; type species of the subgenus *Spiralta*; 1. front view; 2. rear view; 3. from right side. height: 23.9 mm; width: 8.2 mm.

4–6. ***Strombina (Spiralta) guppyi*** Woodring 13
NMB H 17059; from NMB locality 15833: Río Gurabo; Mao Formation (middle or late Pliocene); 4. front view; 5. rear view; 6. from right side. height: 22.6 mm; width: 8.6 mm.

7–9. ***Strombina (Sincola) gurabensis*** (Maury) 15
NMB H 17063; from NMB locality 15907: Río Gurabo; upper part of Cercado Formation; 7. front view; 8. rear view; 9. from right side. Specimen without denticles on inner surface of outer lip. height: 10.1 mm; width: 4.8 mm.

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EXPLANATION OF PLATE 4

Figure | Page

1–9. ***Strombina* (*Sincola*) *gurabensis*** (Maury) 15

1–3. Holotype, PRI 28734; Río Gurabo at Los Quemados; upper part of Cercado Formation; 1. front view; 2. rear view; 3. from right side. Specimen is not quite adult. height: 7.3 mm; width: 3.4 mm.

4–9. Front views of six specimens showing variability of general outline, sculpture on early spire whorls, development of outer lip, and development of denticles on its inner surface.

4–6. All from NMB locality 15912: Río Gurabo; upper part of Cercado Formation; 4. NMB H 17060. height: 9.7 m; width: 5.2 mm; 5. NMB H 17061. height: 8.9 mm; width: 4.6 mm; 6. NMB H 17062. height: 9.2 mm; width: 5.3 mm.

7–9. All from NMB locality 15907: Río Gurabo; upper part of Cercado Formation; 7. NMB H 17065. height: 9.5 mm; width: 4.9 mm; 8. NMB H 17066. height: 9.8 mm; width: 4.4 mm; 9. NMB H 17068. height: 10.1 mm; width: 4.7 mm.

EXPLANATION OF PLATE 5

Figure	Page
1–9. ***Strombina (Sincola) pseudohaitensis*** (Maury)	16

1–3. Lectotype, PRI 28733; Río Mao, Bluff 3 of Maury; Cercado Formation; 1. front view; 2. rear view; 3. from right side. height: 8.8 mm; width: 5.1 mm.

4–6. Paralectotype, PRI 30582; Río Mao, Bluff 3 of Maury; Cercado Formation; 4. front view; 5. rear view; 6. from right side. height: 8.7 mm; width: 4.9 mm.

7–9. Front views of three specimens showing variability of sculpture on spire whorls, thickness of outer lip, and development of denticles on its inner surface. All from NMB locality 16924: Río Mao; Cercado Formation; 7. NMB H 17075. height: 8.4 mm; width: 4.6 mm; 8. NMB H 17076. height: 7.7 mm; width: 4.4 mm; 9. NMB H 17077. height: 7.6 mm; width: 4.5 mm.

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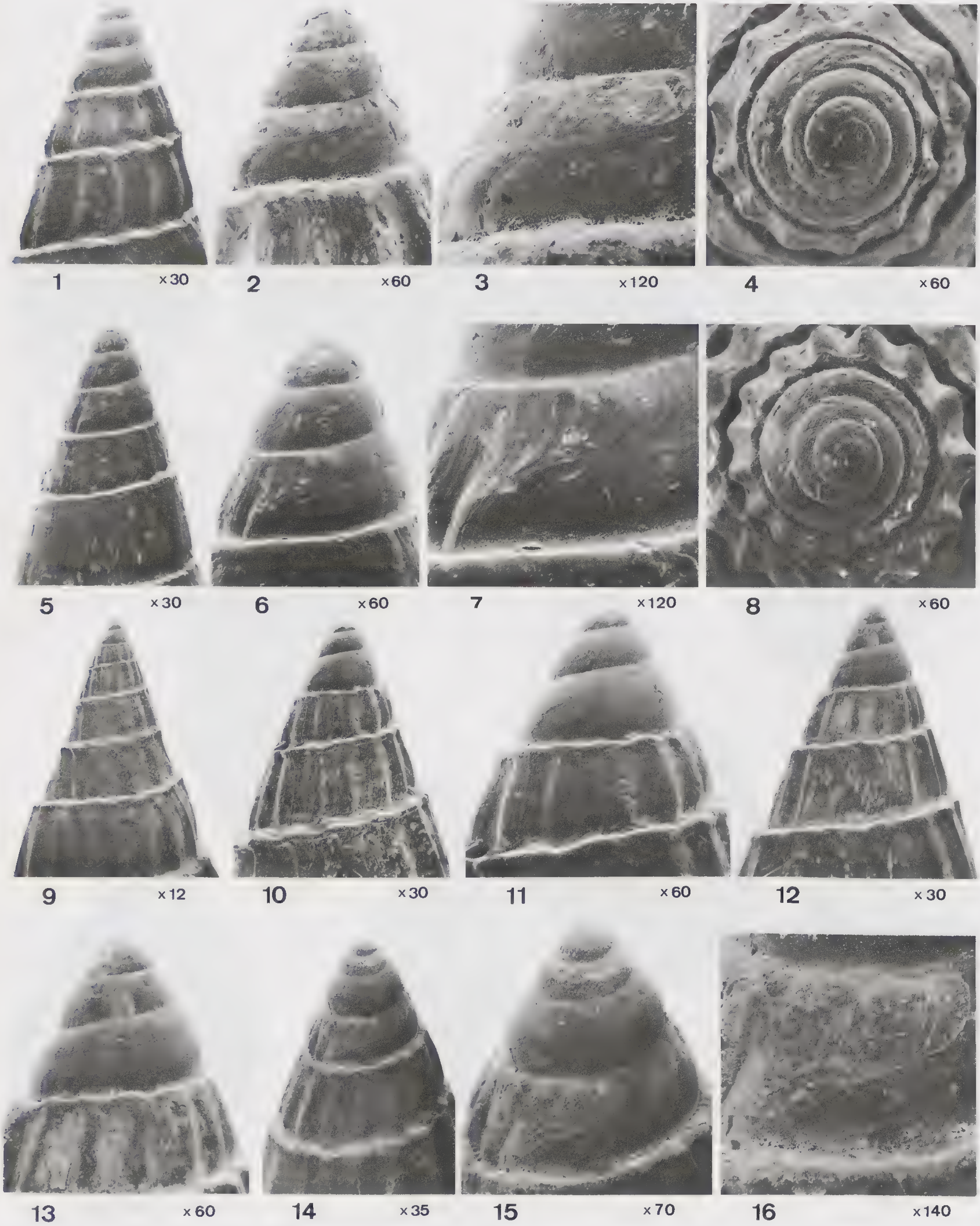

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5 ×30 6 ×60 7 ×120 8 ×60

9 ×12 10 ×30 11 ×60 12 ×30

13 ×60 14 ×35 15 ×70 16 ×140

EXPLANATION OF PLATE 6

Figure Page

1–7. ***Strombina (Sincola) gurabensis*** (Maury) ... 15

1–3. NMB H 17019; from NMB locality 15912: Río Gurabo; upper part of Cercado Formation. Note long sinusigerous outer lip of protoconch; 1. ×30; 2. ×60; 3. ×120.

4. NMB H 17022; from NMB locality 15914: Río Gurabo; upper part of Cercado Formation.Very slightly oblique apical view; ×60.

5–7. NMB H 17021; from NMB locality 15912: Río Gurabo; upper part of Cercado Formation. Note sinusigerous outer lip of protoconch which is somewhat shorter than that of the specimen shown in figures 1–3; 5. ×30; 6. ×60; 7. ×120.

8–16. ***Strombina (Sincola) pseudohaitensis*** (Maury) ... 16

8. NMB H 17027; from NMB locality 16913: Río Mao; Cercado Formation. Very slightly oblique apical view; ×60.

9–11. NMB H 17028; from NMB locality 16913: Río Mao; Cercado Formation; 9. ×12; 10. ×30; 11. ×60.

12–13. NMB H 17029; from NMB locality 16913: Río Mao; Cercado Formation; 12. ×30; 13. ×60.

14–16. NMB H 17030; from NMB locality 16927: Río Mao; Cercado Formation. Note sinusigerous outer lip of protoconch; oblique apical views; 14. ×35; 15. ×70; 16. ×140.

EXPLANATION OF PLATE 7

Figure		Page
1–12.	***Strombina (Sincola) caribaea*** Gabb	18

1–3. Holotype of *S. caribaea micra* Pilsbry, ANSP 2800; precise locality in Dominican Republic not known; 1. front view; 2. rear view; 3. from right side. height: 5.8 mm; width: 2.7 mm.

4–6. Lectotype of *S. caribaea*, ANSP 3996; precise locality in Dominican Republic not known. Specimen figured by Pilsbry (1922, pl. 18, fig. 9); 4. front view; 5. rear view; 6. from right side. height: 10.2 mm; width: 5.2 mm.

7–9. NMB H 17081; from NMB locality 17288: Río Yaque del Norte (López section); Baitoa Formation. Immature specimen corresponding to *S. caribaea micra*; 7. front view; 8. rear view; 9. from right side. height: 6.1 mm; width: 2.9 mm.

10–12. NMB H 17078; from NMB locality 16942: Río Yaque del Norte (López section); Baitoa Formation; 10. front view; 11. rear view; 12. from right side. height: 9.1 mm; width: 4.8 mm.

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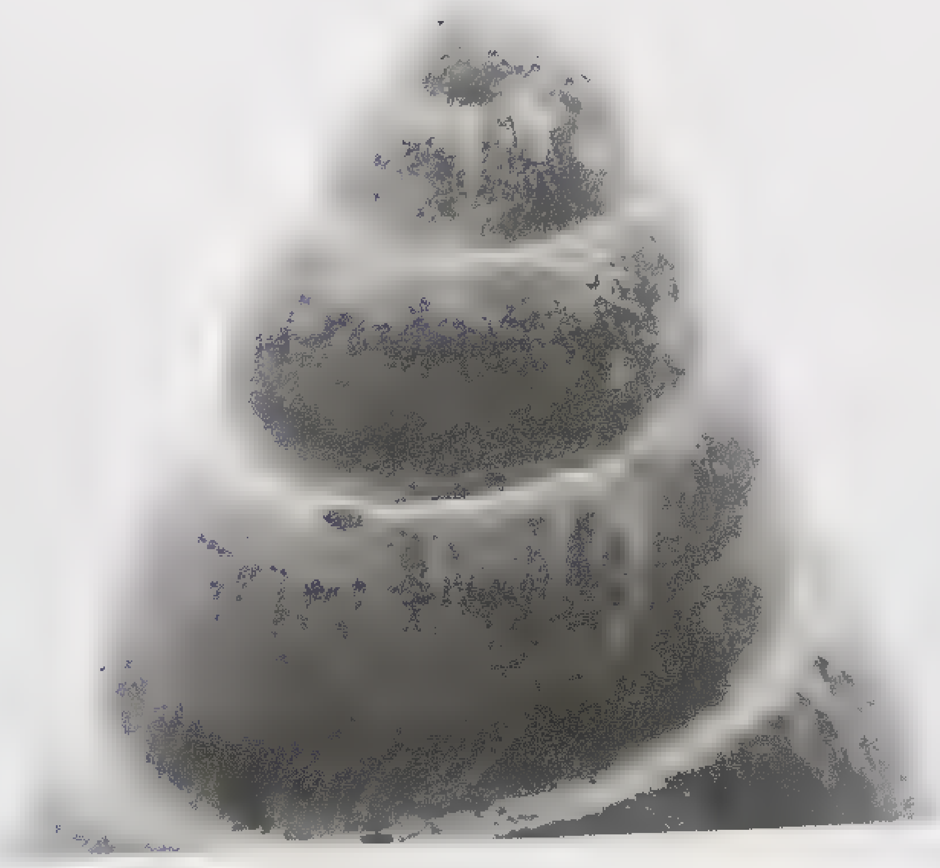
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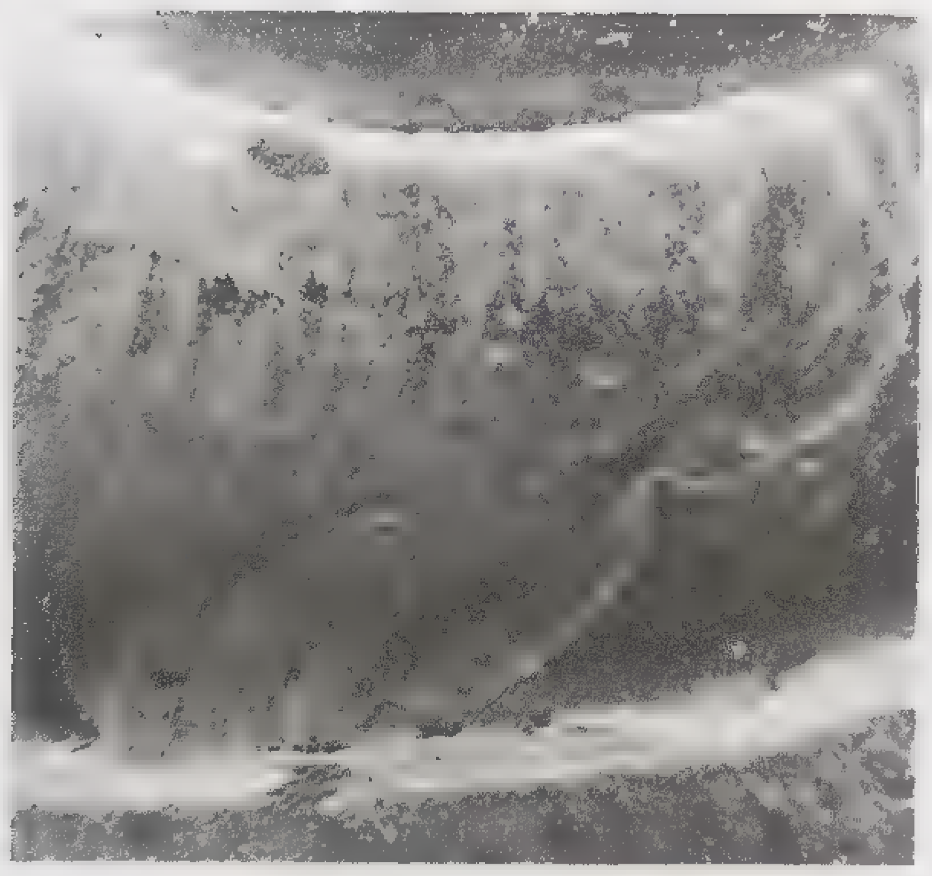
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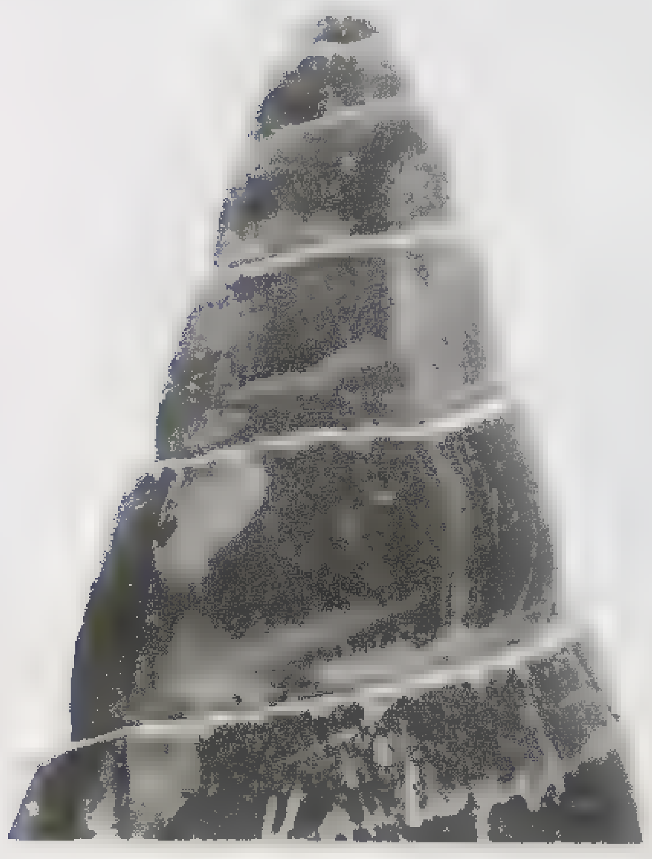
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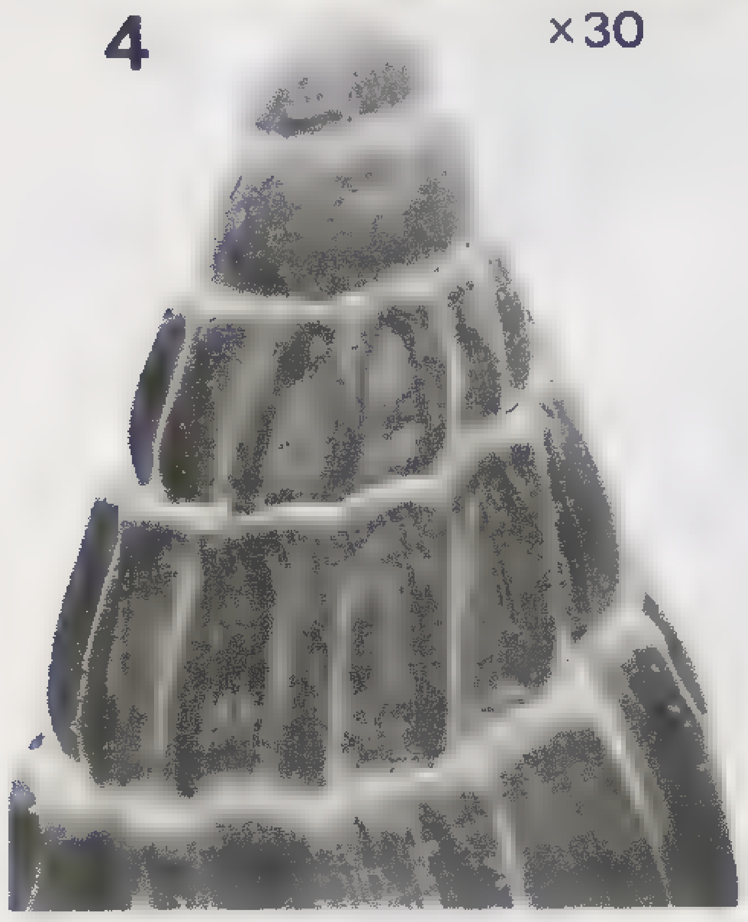
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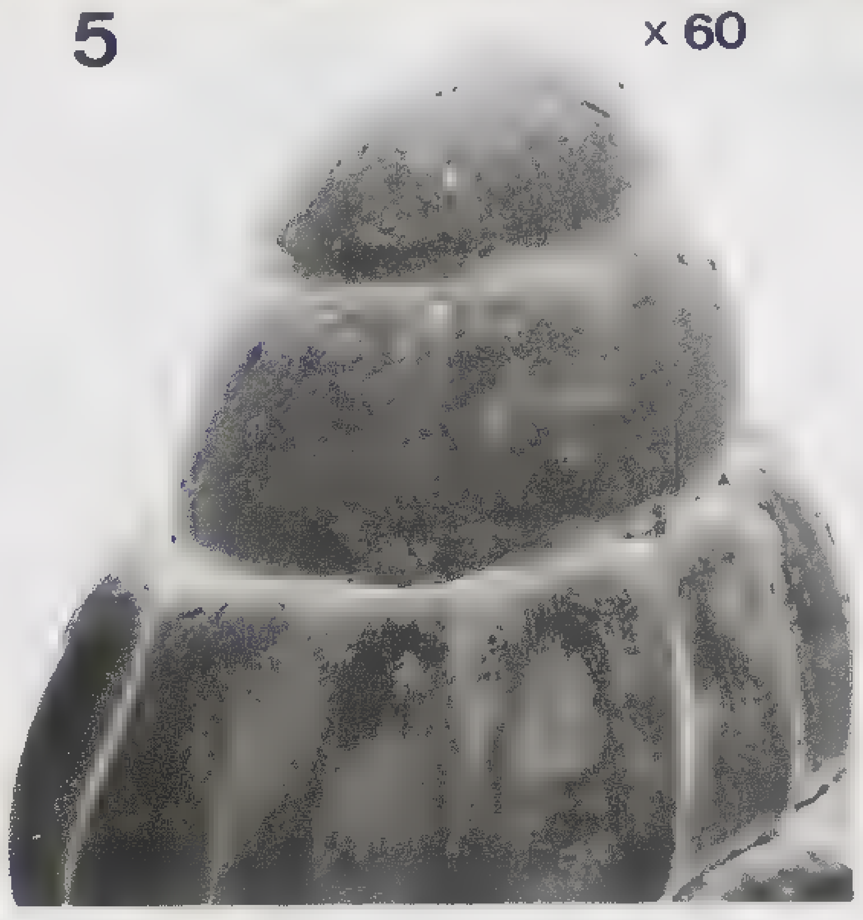
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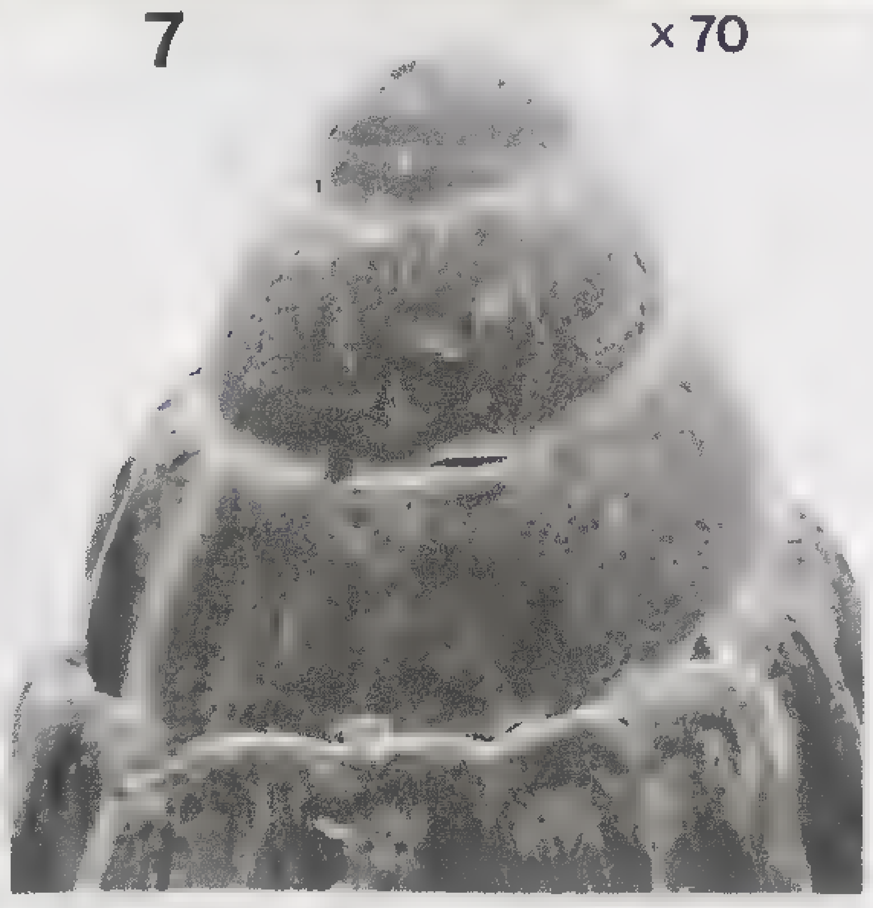
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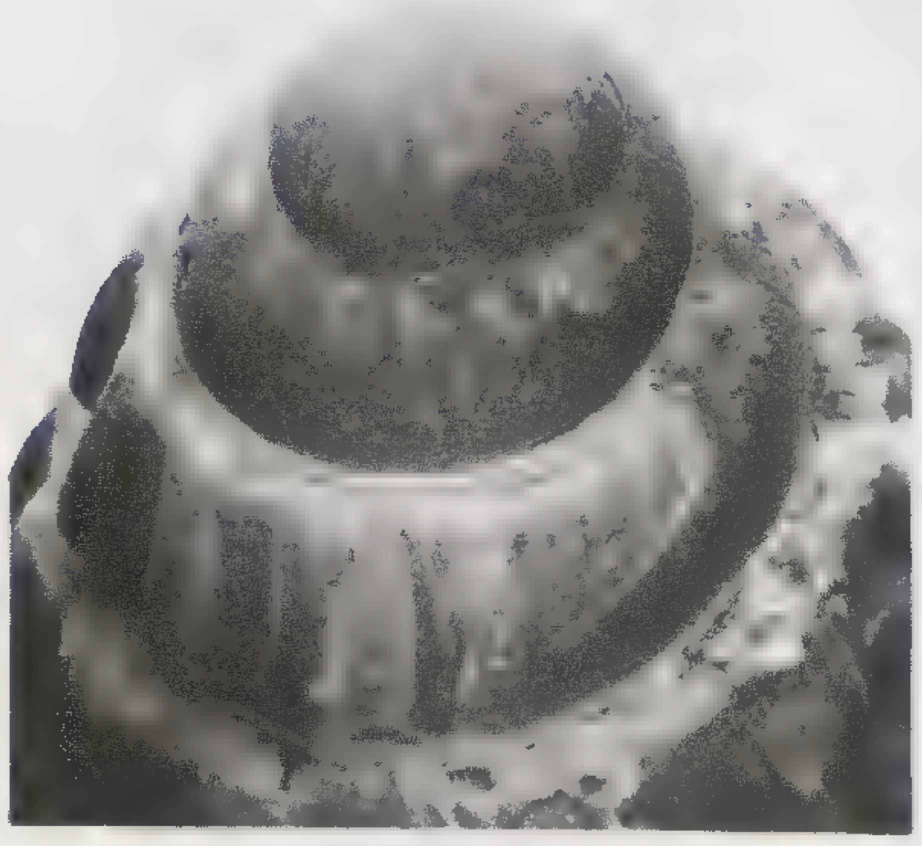
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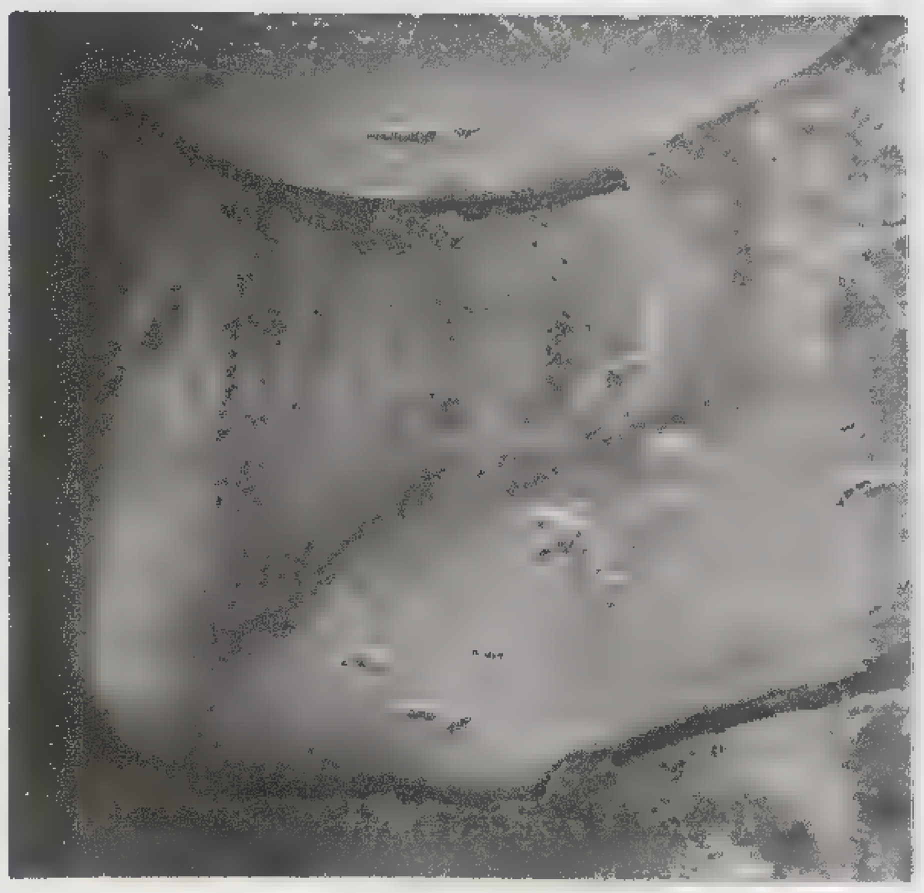
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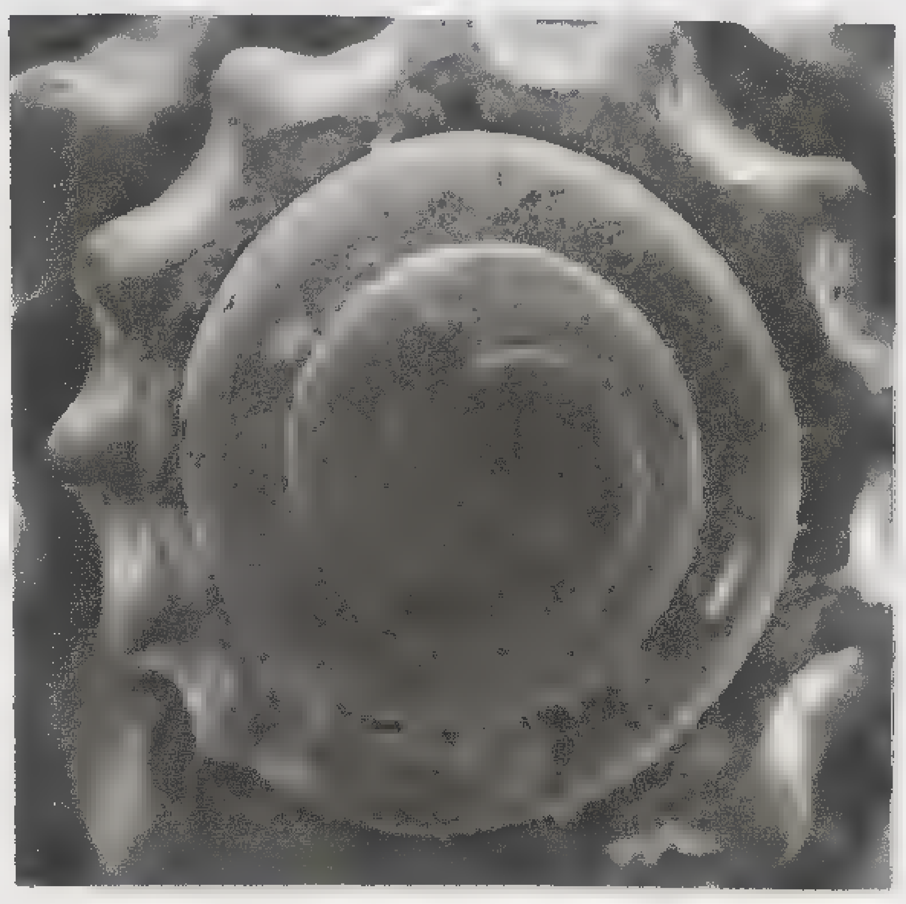
14 × 70

EXPLANATION OF PLATE 8

Figure — Page

1–7. ***Strombina (Sincola) caribaea*** Gabb 18

1–3. NMB H 17032; from NMB locality 16936: Río Yaque del Norte (López section); Baitoa Formation. Note sinusigerous outer lip of protoconch; 1. ×30; 2. ×60; 3. ×125.

4–5. NMB H 17033; from NMB locality 17288: Río Yaque del Norte (López section); Baitoa Formation; 4. ×30; 5. ×60.

6–7. NMB H 17034; from NMB locality 17288: Río Yaque del Norte (López section); Baitoa Formation. Note sinusigerous outer lip of protoconch; 6. oblique apical view, ×70; 7. apical view, ×70.

8–14. ***Strombina (Sincola) bassi*** (Maury) 19

8–9. NMB H 17090; from NMB locality 16856: Río Cana; Cercado Formation; 8. ×35; 9. ×70.

10–11. NMB H 17091; from NMB locality 16856: Río Cana; Cercado Formation; 10. ×30; 11. note sinusigerous outer lip of protoconch, ×65.

12–14. NMB H 17092; from NMB locality 16856: Río Cana; Cercado Formation. Note sinusigerous outer lip of protoconch; 12. oblique apical view, ×70; 13. ×140; 14. apical view, ×70.

EXPLANATION OF PLATE 9

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1–6. ***Strombina*** **(*Sincola*)** ***bassi*** (Maury) 19

1–3. Holotype, PRI 28736; Río Gurabo at Los Quemados; Maury's Zones D and E; 1. front view; 2. rear view; 3. from right side. height: 11.0 mm; width: 5.3 mm.

4–6. NMB H 17087; from NMB locality 16857: Río Cana; Cercado Formation; 4. front view; 5. rear view; 6. from right side. height: 12.2 mm; width: 6.2 mm.

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EXPLANATION OF PLATE 10

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1–13. ***Strombina* (*Sincola*) *nanniebellae*** (Maury) 20

1–3. Lectotype, PRI 28735; Río Cana at Caimito; Maury's Zones H and I; specimen figured by Maury (1917a, pl. 15, fig. 15); 1. front view; 2. rear view; 3. from right side. height: 12.4 mm; width: 6.8 mm.

4–10. Front views of seven specimens showing variability of sculpture on early spire whorls, development of outer lip, and development of denticles on its inner surface; all from NMB locality 16856: Río Cana; Cercado Formation; 4. NMB H 17047. height: 10.9 mm; width: 6.6 mm; 5. NMB H 17048. height: 11.2 mm; width: 6.9 mm; 6. NMB H 17049. height: 11.2 mm; width: 6.6 mm; 7. NMB H 17050. height: 11.9 mm; width: 7.2 mm; 8. NMB H 17051. height: 12.8 mm; width: 7.2 mm; 9. NMB H 17052. height: 10.6 mm; width: 6.2 mm; 10. NMB H 17053. height: 12.2 mm; width: 6.9 mm.

11–13. NMB H 17054; from NMB locality 16844: Río Cana; Cercado Formation; 11. front view; 12. from right side; 13. rear view. height: 10.8 mm; width: 6.5 mm.

EXPLANATION OF PLATE 11

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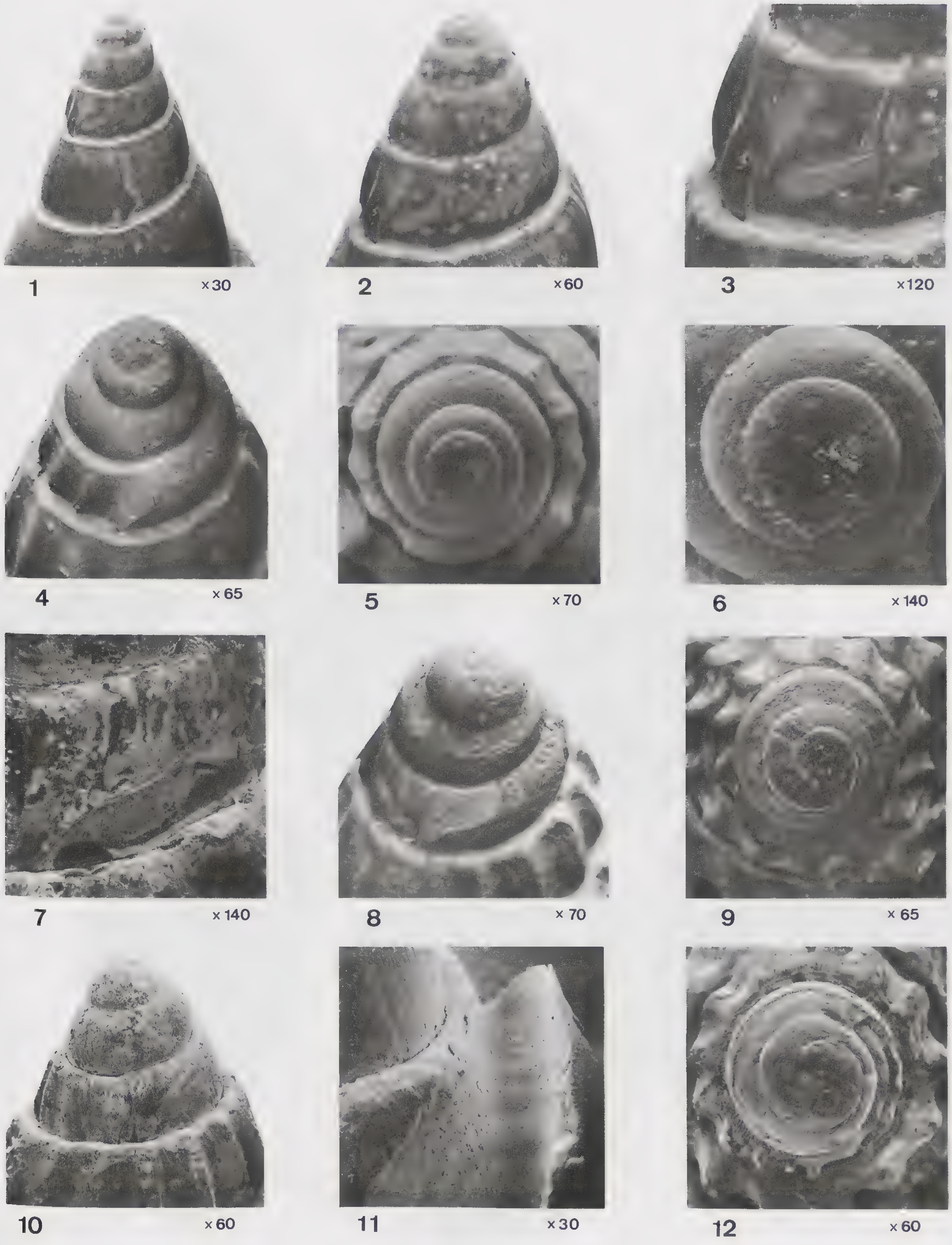
1–9. ***Strombina* (*Sincola*) *nanniebellae*** (Maury) 20
1–3. NMB H 17044; from NMB locality 16856: Río Cana; Cercado Formation. Note sinusigerous outer lip of protoconch; 1. ×30; 2. ×60; 3. ×120.
4–6. NMB H 17045; from NMB locality 16856: Río Cana; Cercado Formation; 4. oblique apical view; note sinusigerous outer lip of protoconch, ×65; 5. apical view, ×70; 6. apical view, ×140.
7. NMB H 17058; from NMB locality 16854: Río Cana; Cercado Formation. Note sinusigerous outer lip of protoconch, ×140.
8–9. NMB H 17056; from NMB locality 16839: Río Cana; Cercado Formation; 8. oblique apical view; note sinusigerous outer lip of protoconch, ×70; 9. apical view, ×65.
10–12. ***Strombina* (*Bifurcium*) *nuestrasenorae*** (Maury) 22
10–11. NMB H 17036; from NMB locality 15873: Río Gurabo; Gurabo Formation; 10. ×60; 11. posterior canal, ×30.
12. NMB H 17035; from NMB locality 15873: Río Gurabo; Gurabo Formation; apical view, ×60.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EXPLANATION OF PLATE 12

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1–9. ***Strombina* (*Bifurcium*) *nuestrasenorae*** (Maury) 22

- 1–3. NMB H 17083; from NMB locality 15873: Río Gurabo; Gurabo Formation; 1. front view; 2. rear view; 3. from right side. height: 9.6 mm; width: 5.4 mm.
- 4–6. Holotype, PRI 28732; Río Gurabo at Los Quemados; Maury's Zone G; 4. front view; 5. rear view; 6. from right side. height: 7.8 mm; width: 4.2 mm.
- 7–9. NMB H 17085; from NMB locality 16857: Río Cana; Cercado Formation; 7. front view; 8. rear view; 9. from right side. height: 10.0 mm; width: 5.6 mm.

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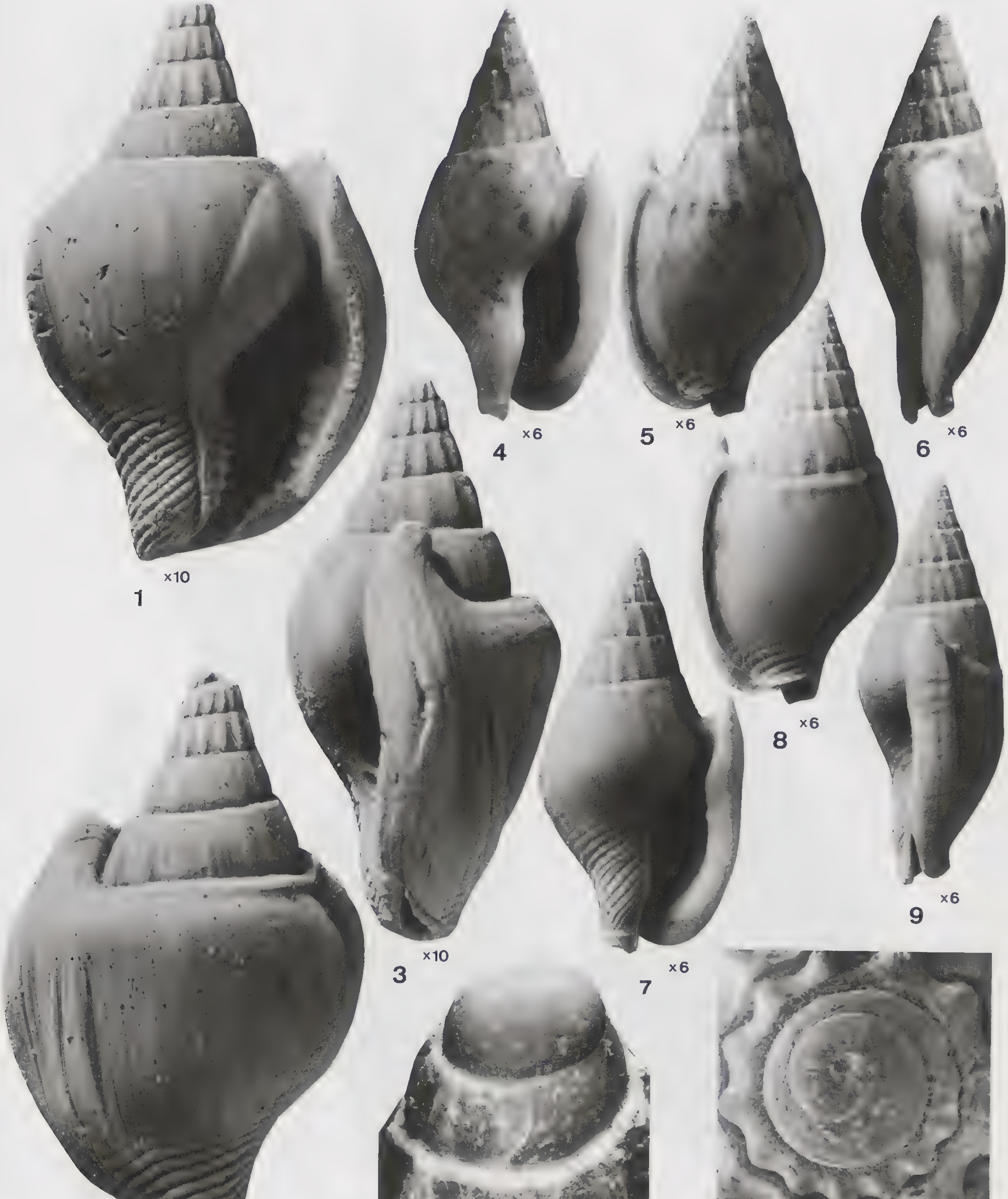
1–3. ***Strombina* (*Bifurcium*)** aff. ***nuestrasenorae*** (Maury) 22
NMB H 17086; from NMB locality 16856: Río Cana; Cercado Formation; 1. front view; 2. rear view; 3. from right side. height: 9.8 mm; width: 6.6 mm.

4–9. ***Strombina* (*Bifurcium*) *bicanalifera*** (G. B. Sowerby I) 22
Syntype, BMNH 1966312; Recent, Galapagos Islands; 4–6. surface not whitened; 7–9. surface whitened; 4, 7. front views; 5, 8. rear views; 6, 9. from right side. height: 12.3 mm; width: 6.1 mm.

10–11. ***Strombina* (*Bifurcium*) *canae*,** new species 23
Paratype, NMB H 17038; from NMB locality 16837: Río Cana; upper part of Cercado Formation; 10. oblique apical view, ×70; 11. apical view, ×65.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EXPLANATION OF PLATE 14

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1–9. ***Strombina (Bifurcium) canae***, new species 23

1–3. Holotype, NMB H 17041; from NMB locality 16837: Río Cana; upper part of Cercado Formation; 1. front view; 2. rear view; 3. from right side. height: 8.1 mm; width: 4.5 mm.

4–6. Paratype, NMB H 17040; from NMB locality 16837: Río Cana; upper part of Cercado Formation; 4. front view; 5. rear view; 6. from right side. height: 8.2 mm; width: 4.4 mm.

7–9. Paratype, NMB H 17043; from NMB locality 15842: Río Gurabo; Gurabo Formation; 7. front view; 8. rear view; 9. from right side. height: 9.4 mm; width: 5.3 mm.

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PREPARATION OF MANUSCRIPTS

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Manuscripts submitted for publication in this monograph series must be typewritten, and double-spaced *throughout* (including direct quotations and references). All manuscripts should contain a table of contents, lists of text-figures and (or) tables, and a short, informative abstract that includes names of all new taxa. Format should follow that of recent numbers in the series. All measurements must be stated in the metric system, alone or in addition to the English system equivalent. The maximum dimensions for photographic plates are 178 mm × 229 mm (7″ × 9″; outlined on this page). Single-page text-figures should be drafted for reproduction as single column (82 mm; 3¼″) or full page (178 mm; 7″) width, but arrangements can be made to publish text-figures that must be larger. Any lettering in illustrations should follow the recommendations of Collinson (1962).

Authors must provide three (3) copies of the text and accompanying illustrative material. The text and line-drawings may be reproduced xerographically, but glossy prints at publication scale must be supplied for all half-tone illustrations and photographic plates. These prints should be identified clearly on the back.

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Original plate photomounts should have oversize cardboard backing and strong tracing paper overlays. These photomounts should be retained by the author until the manuscript has been formally accepted for publication. Explanations of text-figures should be interleaved on separate numbered pages within the text, and the approximate position of the text-figure in the text should be indicated. Explanations of plates follow the Bibliography.

Authors are requested to enclose $10 with each manuscript submitted, to cover costs of postage during the review process.

Collinson, J.
1962. *Size of lettering for text-figures.* Journal of Paleontology, vol. 36, p. 1402.

Gilbert Dennison Harris
(1864 - 1952)

Founder of the *Bulletins of American Paleontology* (1895)

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